

# Anatomy: Posterior Abdomen and Pelvis

Question 1 of 119

The ureters arise at which of the following vertebral levels:

- a T10
- b T11
- c T12
- d L
- e L2

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See Answer



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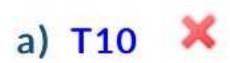


# Anatomy: Posterior Abdomen and Pelvis

Question 1 of 119



The ureters arise at which of the following vertebral levels:



**b)** T11 c) T12

d) L1

e) L2

#### Answer

The ureters are continuous superiorly with the renal pelvis at the ureteropelvic junction (at the level of the renal hilum, vertebra L1).

#### Notes

The ureters are muscular tubes that transport urine from the kidneys to the bladder. They are continuous superiorly with the renal pelvis at the ureteropelvic junction (at the level of the renal hilum, vertebra L1).

#### Anatomical course and relations

Inferior to the ureteropelvic junction, the ureters descend retroperitoneally on the medial aspect of the psoas major muscle, anterior to the tips of the transverse processes of the lower lumbar vertebrae. The ureters cross the pelvic brim anterior to the bifurcation of the common iliac arteries to enter the pelvic cavity and continue their journey down the lateral pelvic walls.

Within the pelvic cavity, the ureters are crossed by the uterine artery lateral to the cervix in women, and by the ductus deferens just posterior to the bladder in men.

At the level of the ischial spines, they turn anteromedially, moving in a transverse plane towards the bladder. The ureters enters obliquely through the base of the bladder at the level of the pubic tubercle.

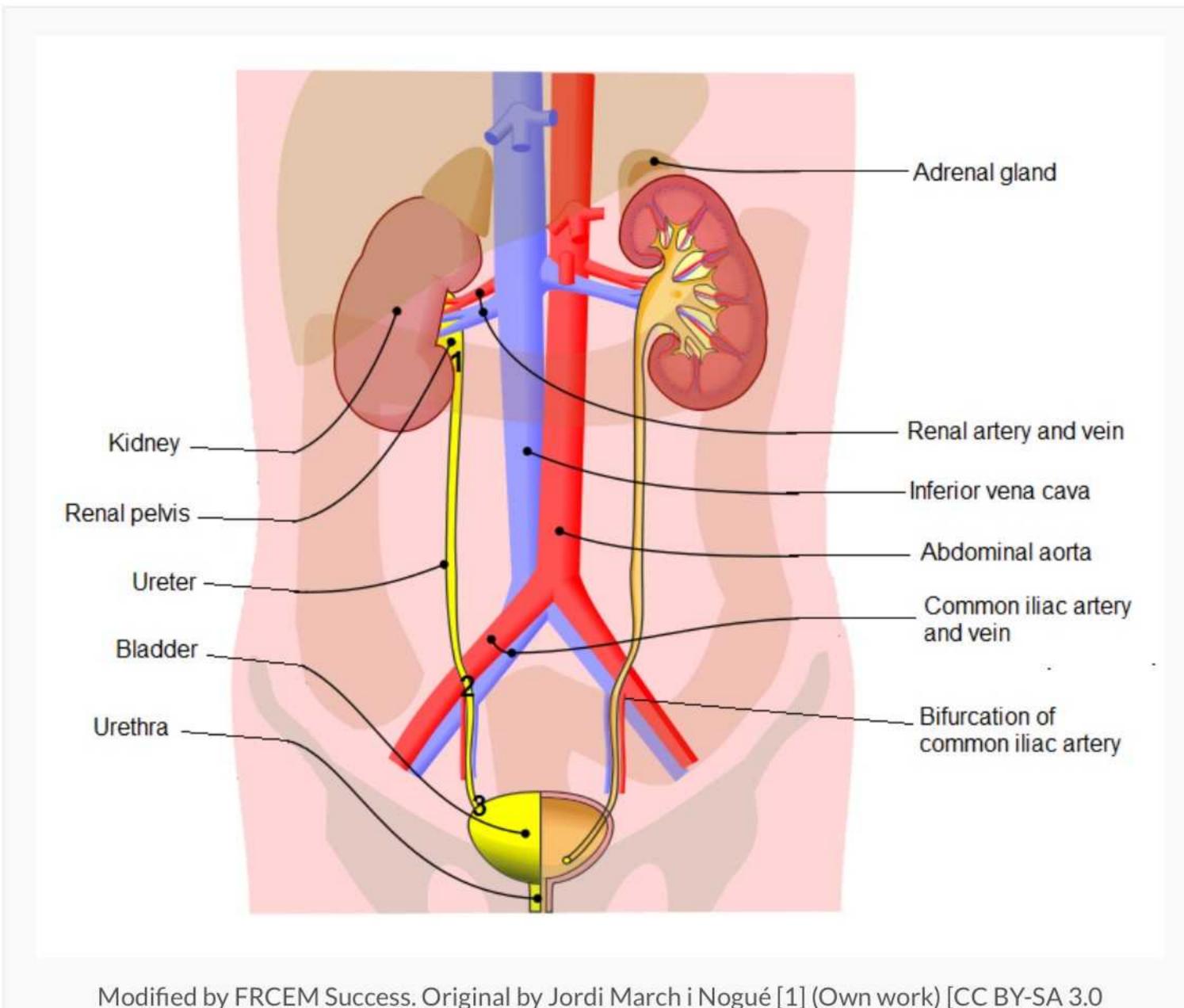
The right ureter lies in close relation to the appendix, and thus be irritated in acute appendicitis causing urinary frequency.

### Constrictions

At three points along their course, the ureters are constricted;

- the first point is at the ureteropelvic junction
- the second point is where the ureters cross the pelvic brim
- the third point is where the ureters enter the wall of the bladder.

Kidneys stones can become lodged at these constrictions.



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## Renal colic pain

Visceral afferent fibres from the ureters enter the spinal cord at T11 - L2, with ureteric pain (usually from ureteric distension) thus referred to the dermatomes supplied by T11 - L2; the posterior and lateral abdominal wall below the ribs and above the iliac crest, the pubic region, the scrotum in males, the labia majora in females and the proximal anterior aspect of the thigh (loin to groin pain).

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# Anatomy: Posterior Abdomen and Pelvis

Question 2 of 119

The left kidney is related anteriorly to all of the following structures EXCEPT for the:

- Head of the pancreas
- Stomach
- Spleen
- Duodenojejunal flexure
- Descending colon

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# Anatomy: Posterior Abdomen and Pelvis

Question 2 of 119

The left kidney is related anteriorly to all of the following structures EXCEPT for the:

- a) Head of the pancreas
- b) Stomach
- c) Spleen
- d) Duodenojejunal flexure e) Descending colon

## Answer

The anterior surface of the left kidney is related to the (superiorly to inferiorly):

- left adrenal gland medially
- spleen laterally (body and tail)
- pancreas
- stomach (the kidney forms part of the stomach bed)
- left colic flexure and descending colon laterally duodenojejunal flexure and coils of small intestine

Kidney

## Notes

Viscera

lateral to the vertebral column in the upper left and right abdominal quadrants.

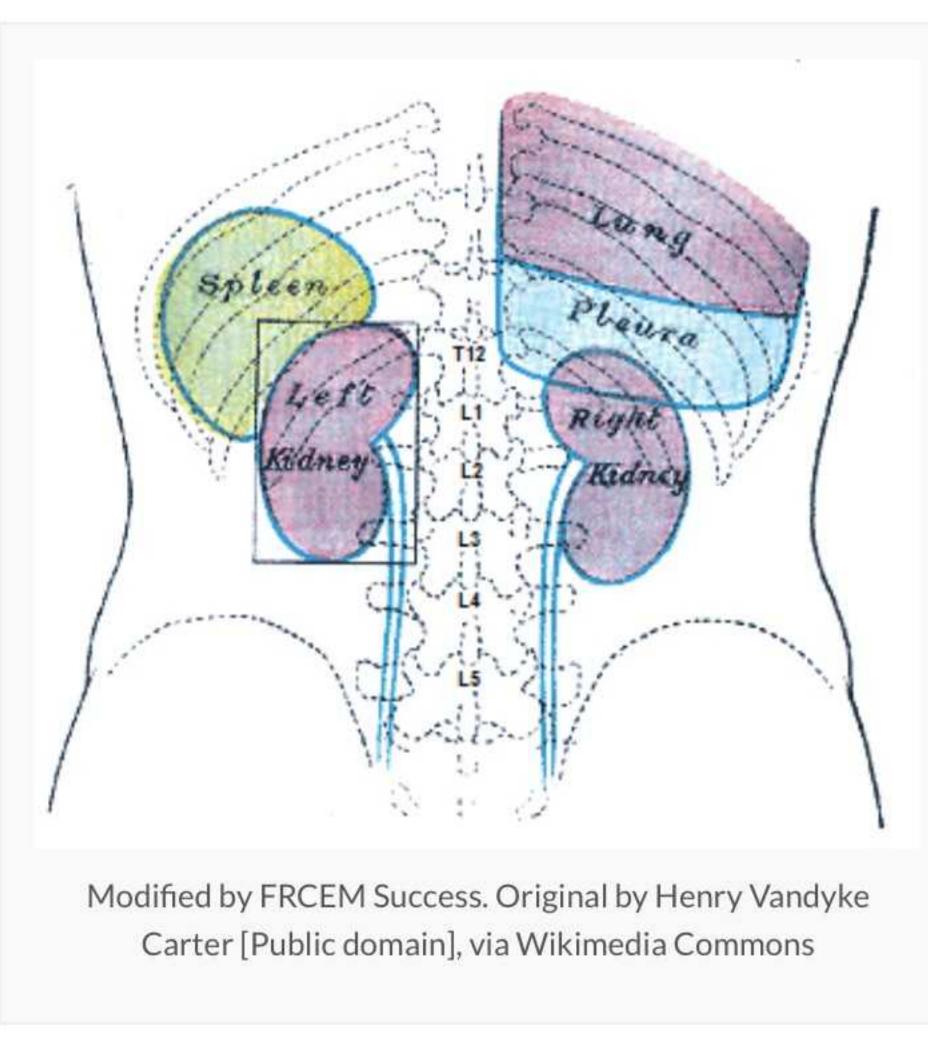
The kidneys are retroperitoneal organs. They lie in the extraperitoneal connective tissue immediately

Surface marking	Extend between vertebrae T12 – L3, left kidney slightly higher than right, renal hila at vertebral level L1	
Anterior relations	RIGHT: right adrenal gland, liver, second part of duodenum, right colic flexure, segment of small intestine. LEFT: left adrenal gland, spleen, pancreas, stomach, left colic flexure and descending colon, duodenojejunal flexure and coils of small intestin	
Posterior relations	Diaphragm, psoas major, quadratus lumborum and transversus abdominis muscles	
Structure	Each kidney covered by fibrous capsule and surrounded by renal fascia, kidney itself made up of outer renal cortex and inner renal medulla, renal pelvis continuous with ureters	
Blood	Renal artery (branch of abdominal aorta arising at vertebral level L1/L2 posterior to the pancreas), divides into segmental arteries to supply renal parenchyma	
Lymphatics	Lumbar (para-aortic) lymph nodes	
Innervation	Via renal plexus, parasympathetic fibres from vagus nerve and sympathetic fibres from thoracic splanchnic nerves	
•		

## The position of the kidneys varies with respiration and the position of the body. In the supine position,

Surface markings

the kidneys extend from approximately vertebra T12 superiorly to vertebra L3 inferiorly. The left kidney is a little higher than the right, reaching as high as rib 11, compared to rib 12 for the right kidney (because of its relationship with the liver). The hila of the kidneys and the beginning of the ureters are at the level of the L1 vertebra.



Relations

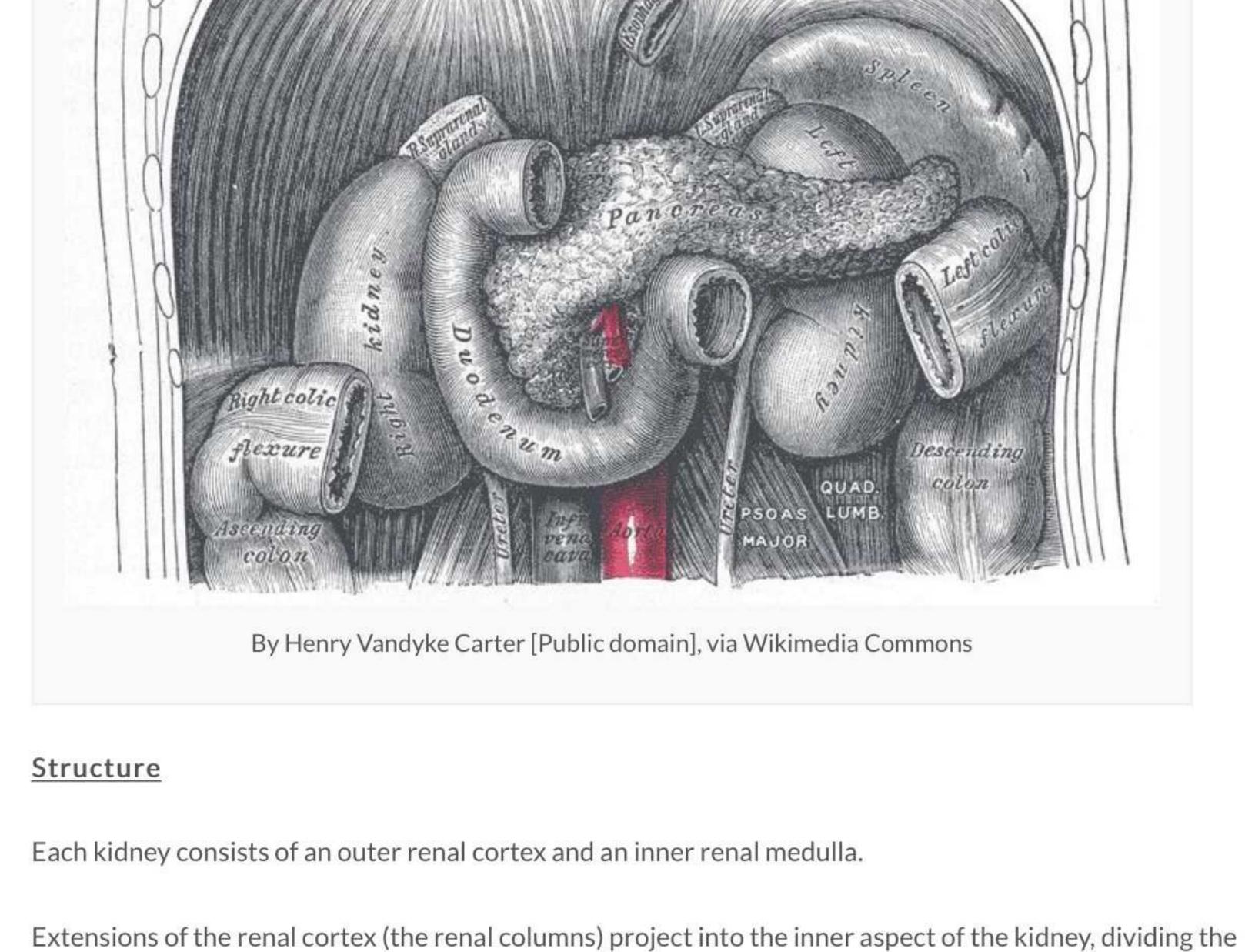
right adrenal gland medially

The anterior surface of the right kidney is related to the (superiorly to inferiorly):

- liver second part of the duodenum medially,
- right colic flexure laterally
- a segment of small intestine medially. The anterior surface of the left kidney is related to the (superiorly to inferiorly):

left adrenal gland medially

- spleen laterally pancreas stomach (the kidney forms part of the stomach bed)
- left colic flexure and descending colon laterally
- duodenojejunal flexure and coils of small intestine
- Posteriorly both kidneys are related superiorly to the diaphragm and ribs and inferiorly (moving from medial to lateral) the psoas major, quadratus lumborum and transversus abdominis muscles. The pleural sacs and the costodiaphragmatic recesses also extend posterior to the kidneys.



## renal medulla into the renal pyramids. The base of the renal pyramids are directed outwards towards the renal cortex, while the apex of each renal pyramid projects inwards towards the renal sinus, a cavity

which is occupied by the renal calyces, blood vessels, nerves and fat. The apical projection of the renal pyramid is surrounded by a minor calyx into which the collecting ducts

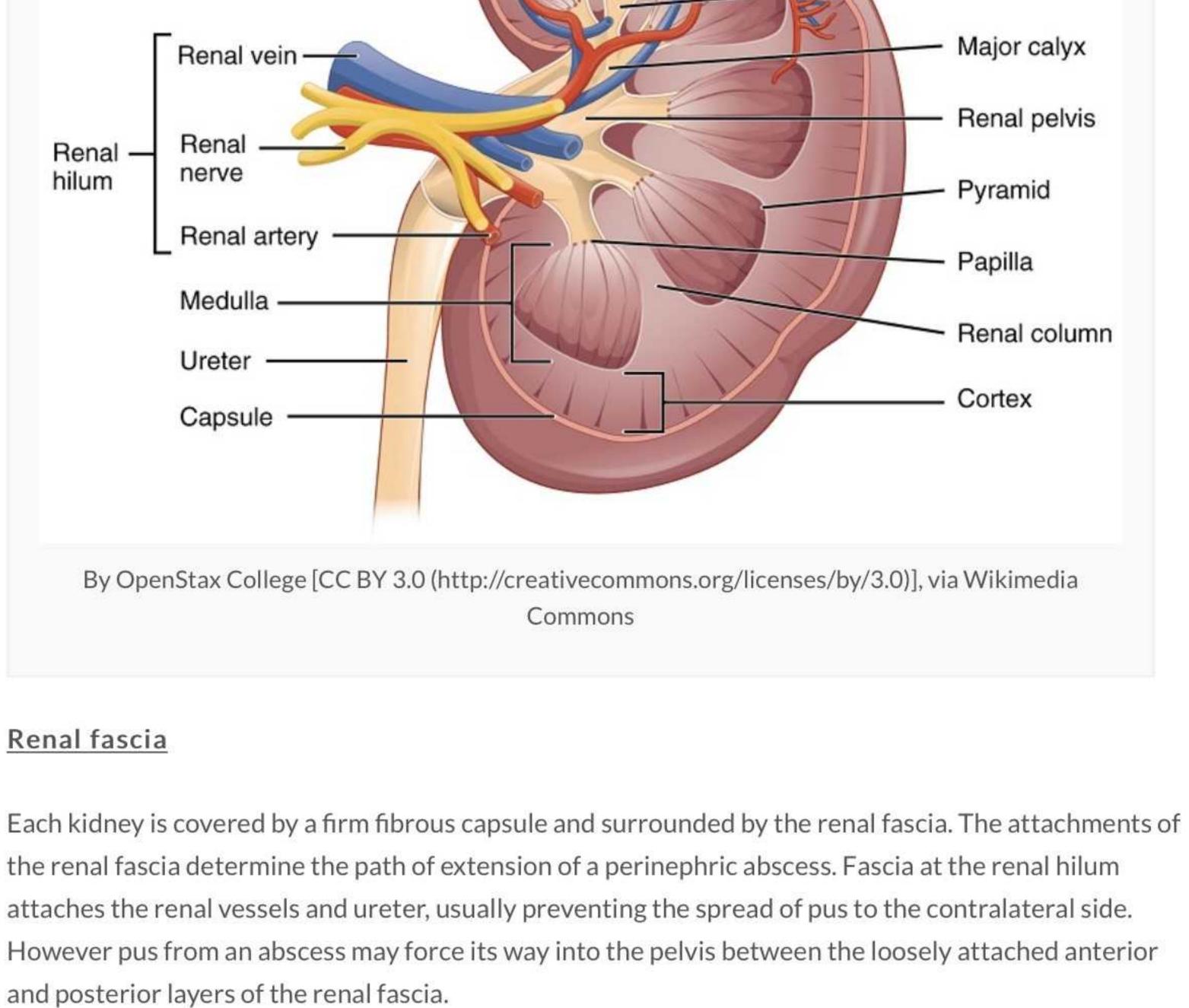
Interlobar

blood vessels

drain. Several minor calyces unite to form a major calyx, and two or three major calyces unite to form the renal pelvis, which is continuous with the ureter. Cortical -Arcuate blood vessels

blood vessels

Minor calyx



**Blood supply** The renal artery arises from the abdominal aorta just inferior to the origin of the superior mesenteric artery just between vertebrae L1 and L2 and posterior to the pancreas.

Each renal artery enters the kidney via the renal hilum, dividing into segmental branches. These branches

undergo further divisions to supply the renal parenchyma. Lymphatic drainage

The lymphatic drainage is to the lumbar (para-aortic) lymph nodes located at the origin of the renal arteries.

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Innervation

The kidneys receive autonomic nerve fibres via the renal plexus which contains parasympathetic fibres from the vagus nerve and sympathetic fibres from the thoracic splanchnic nerves.

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# Anatomy: Posterior Abdomen and Pelvis

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The iliacus muscle acts to produce which of the following movements:

- Flexion of the thigh at the hip joint
- Extension of the thigh at the hip joint
- Lateral flexion of the trunk
- Extension of the trunk
- Lateral rotation of the thigh at the hip joint

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# Anatomy: Posterior Abdomen and Pelvis

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The iliacus muscle acts to produce which of the following movements:

- a) Flexion of the thigh at the hip joint
- b) Extension of the thigh at the hip joint
- c) Lateral flexion of the trunk
- d) Extension of the trunk
- e) Lateral rotation of the thigh at the hip joint

## Answer

Like the psoas major, the iliacus flexes the thigh at the hip joint when the trunk is stabilised and flexes the trunk against gravity when the body is supine.

## Notes

The most important muscles of the posterior abdominal wall are the psoas major, the iliacus and the quadratus lumborum which each possess a strong fascial covering. Associated with the psoas major muscle is the psoas minor muscle, which is sometimes absent.

Muscle	Extent	Action	Innervation
Psoas major (green)	Originates from vertebrae T12 – L5, covers anterolateral bodies of lumbar vertebrae and fills in spaces between vertebral bodies and transverse processes, passes inferiorly along pelvic brim and attaches distally to lesser trochanter of femur	Flexes thigh at hip joint when trunk is stabilised, flexes trunk against gravity when body is supine	Anterior rami L1 – L3
Quadratus lumborum (blue)	Fills space between rib 12 and iliac crest on both sides of vertebral column, overlapped medially by psoas major muscle, lies medial to transversus abdominis muscle	Depresses and stabilises twelfth rib, contributes to lateral bending of trunk	Anterior rami of T12 and L1 - L4
lliacus (red)	Fills iliac fossa on each side before passing inferiorly to join with psoas major muscle and attach distally to lesser trochanter of femur	Flexes thigh at hip joint when trunk is stabilised, flexes trunk against gravity when body is supine	Femoral nerve (L2 – L4)

#### Psoas major

The psoas major originates from the lateral bodies of, the transverse processes of and the intervertebral discs between the T12 and L1 - L5 vertebrae, essentially covering the anterolateral surface of the bodies of the lumbar vertebrae and filling in the spaces between the vertebral bodies and the transverse processes. It passes inferiorly along the pelvic brim and continues into the anterior thigh to attach to the lesser trochanter of the femur.

The psoas major flexes the thigh at the hip joint when the trunk is stabilised and flexes the trunk against gravity when the body is supine.

It is innervated by the anterior rami of nerves L1 – L3.

The lumbar plexus forms within the psoas major muscle, anterior to its attachment to the transverse process of the lumbar vertebrae.

## Quadratus lumborum

The quadratus lumborum muscles essentially fill the space between rib 12 and the iliac crest on both sides of the vertebral column. They are overlapped medially by the psoas major muscles and along their lateral borders are the transversus abdominis muscles.

The quadratus lumborum muscles depress and stabilise the twelfth ribs and contribute to lateral bending of the trunk. Acting together, the muscles may extend the lumbar part of the vertebral column.

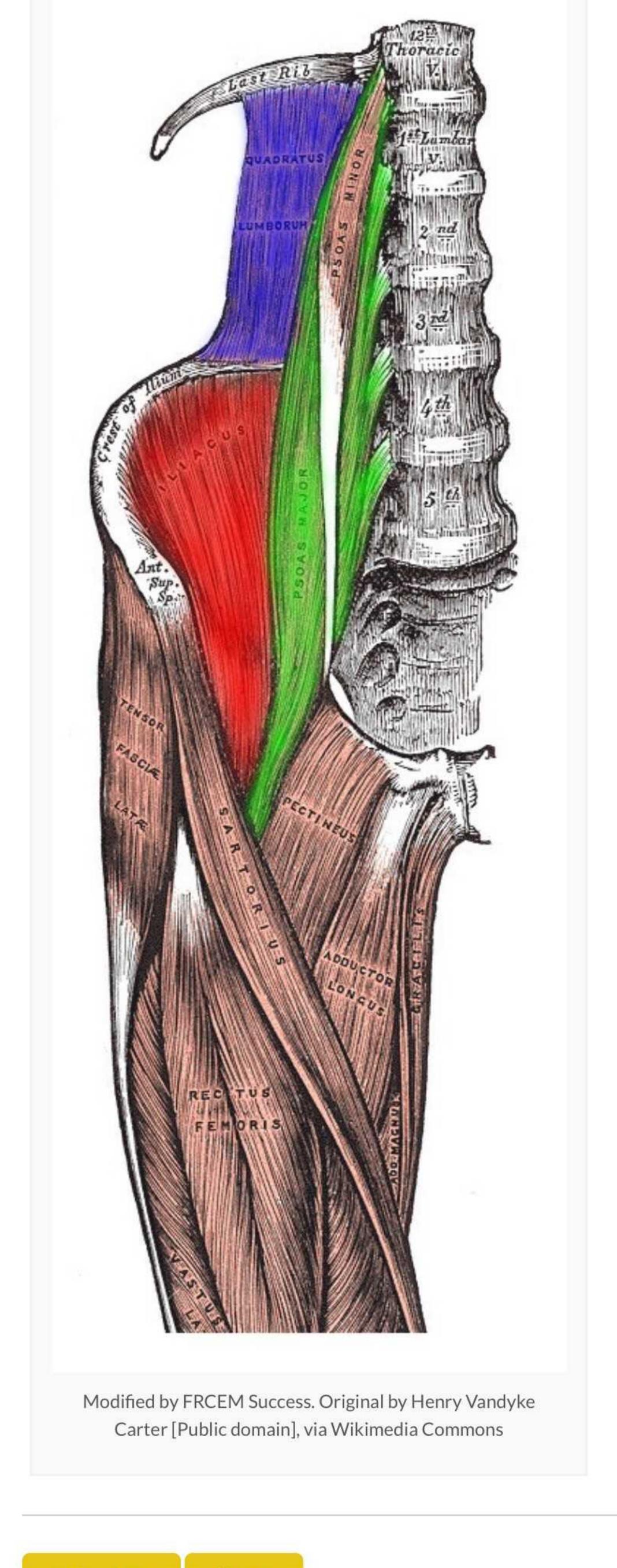
They are innervated by the anterior rami of T12 and L1 - L4.

## Iliacus

The iliacus muscle fills the iliac fossa on each side, before passing inferiorly to join with the psoas major muscle (forming the iliopsoas muscle) and attach to the lesser trochanter of the femur.

trunk against gravity when the body is supine. It is innervated by branches of the femoral nerve.

Like the psoas major, the iliacus flexes the thigh at the hip joint when the trunk is stabilised and flexes the



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# Anatomy: Posterior Abdomen and Pelvis

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- Iliohypogastric nerve
- Ilioinguinal nerve
- Anterior rami of L2 L4
- Anterior rami of T9 T12
- Anterior rami of T12 L4

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# Anatomy: Posterior Abdomen and Pelvis

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The quadratus lumborum muscle is innervated by which of the following:

- a) Iliohypogastric nerve
- b) Ilioinguinal nerve
- c) Anterior rami of L2 L4
- d) Anterior rami of T9 T12
- e) Anterior rami of T12 L4

#### Answer

The quadratus lumborum muscles are innervated by the anterior rami of T12 and L1 – L4.

## Notes

The most important muscles of the posterior abdominal wall are the psoas major, the iliacus and the quadratus lumborum which each possess a strong fascial covering. Associated with the psoas major muscle is the psoas minor muscle, which is sometimes absent.

Muscle	Extent	Action	Innervation
Psoas major (green)	Originates from vertebrae T12 – L5, covers anterolateral bodies of lumbar vertebrae and fills in spaces between vertebral bodies and transverse processes, passes inferiorly along pelvic brim and attaches distally to lesser trochanter of femur	Flexes thigh at hip joint when trunk is stabilised, flexes trunk against gravity when body is supine	Anterior rami L1 – L3
Quadratus lumborum (blue)	Fills space between rib 12 and iliac crest on both sides of vertebral column, overlapped medially by psoas major muscle, lies medial to transversus abdominis muscle	Depresses and stabilises twelfth rib, contributes to lateral bending of trunk	Anterior rami of T12 and L1 - L4
Iliacus (red)	Fills iliac fossa on each side before passing inferiorly to join with psoas major muscle and attach distally to lesser trochanter of femur	Flexes thigh at hip joint when trunk is stabilised, flexes trunk against gravity when body is supine	Femoral nerve (L2 – L4)

#### Psoas major

The psoas major originates from the lateral bodies of, the transverse processes of and the intervertebral discs between the T12 and L1 - L5 vertebrae, essentially covering the anterolateral surface of the bodies of the lumbar vertebrae and filling in the spaces between the vertebral bodies and the transverse processes. It passes inferiorly along the pelvic brim and continues into the anterior thigh to attach to the lesser trochanter of the femur.

The psoas major flexes the thigh at the hip joint when the trunk is stabilised and flexes the trunk against gravity when the body is supine.

It is innervated by the anterior rami of nerves L1 – L3.

The lumbar plexus forms within the psoas major muscle, anterior to its attachment to the transverse process of the lumbar vertebrae.

## Quadratus lumborum

The quadratus lumborum muscles essentially fill the space between rib 12 and the iliac crest on both sides of the vertebral column. They are overlapped medially by the psoas major muscles and along their lateral borders are the transversus abdominis muscles.

The quadratus lumborum muscles depress and stabilise the twelfth ribs and contribute to lateral bending of the trunk. Acting together, the muscles may extend the lumbar part of the vertebral column.

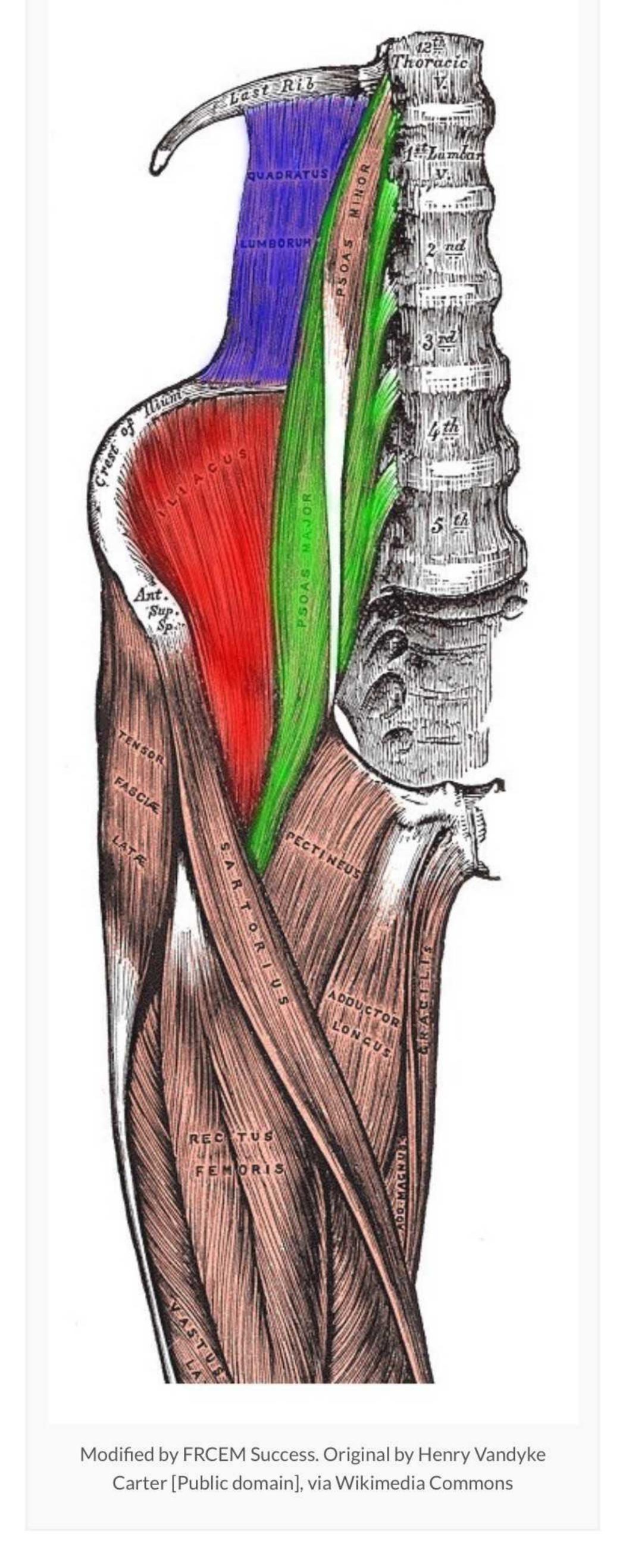
They are innervated by the anterior rami of T12 and L1 – L4.

## <u>Iliacus</u>

The iliacus muscle fills the iliac fossa on each side, before passing inferiorly to join with the psoas major muscle (forming the iliopsoas muscle) and attach to the lesser trochanter of the femur.

Like the psoas major, the iliacus flexes the thigh at the hip joint when the trunk is stabilised and flexes the trunk against gravity when the body is supine.

It is innervated by branches of the femoral nerve.



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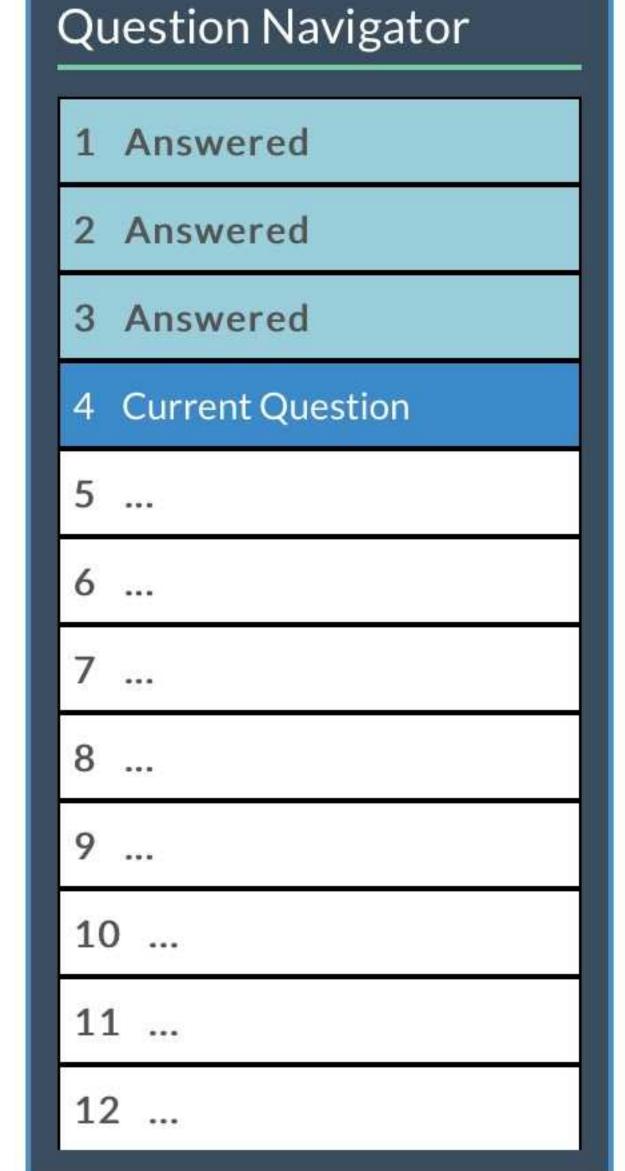
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- Preprostatic urethra
- b Prostatic urethra
- Membranous urethra
- Spongy urethra
- Urethral crest

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# Anatomy: Posterior Abdomen and Pelvis

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Which of the following parts of the urethra penetrates the urogenital diaphragm:

- a) Preprostatic urethra
- b) Prostatic urethra
- c) Membranous urethra
- d) Spongy urethra

e) Urethral crest

#### Answer

The membranous part of the urethra is the narrowest part and passes through the urogenital diaphragm. During its transit through the pelvic floor, in both men and women, it is surrounded by skeletal muscle of the external urethral sphincter.

#### Notes

The urethra begins at the base of the bladder and ends with an external opening in the perineum.

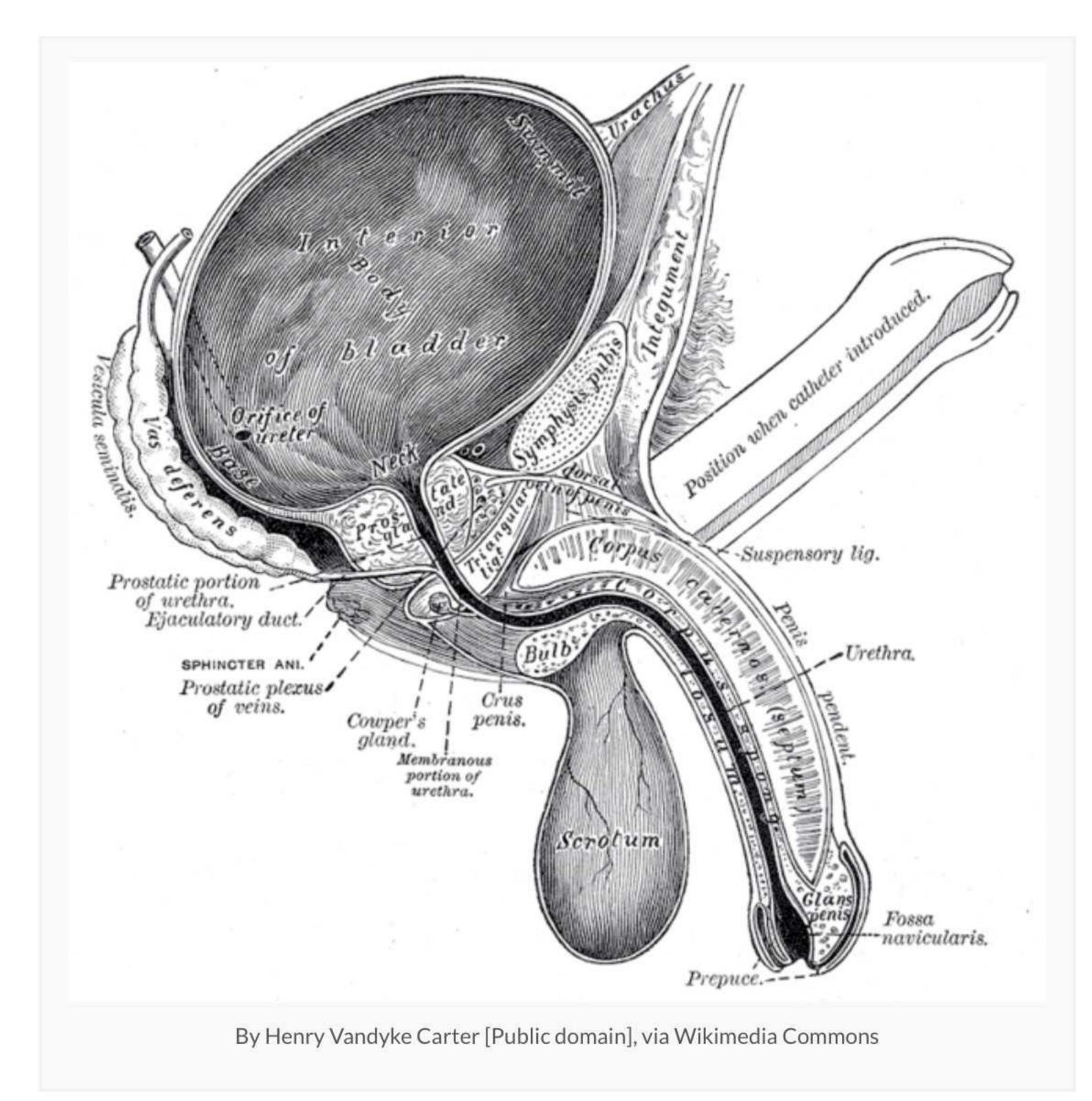
## Female urethra

In women the urethra is short (about 4 cm long). It passes inferiorly through the urogenital diaphragm into the perineum before opening in the vestibule that lies between the labia minora. The inferior aspect of the urethra is bound to the anterior surface of the vagina. The urethral opening is anterior to the vaginal opening in the vestibule.

#### Male urethra

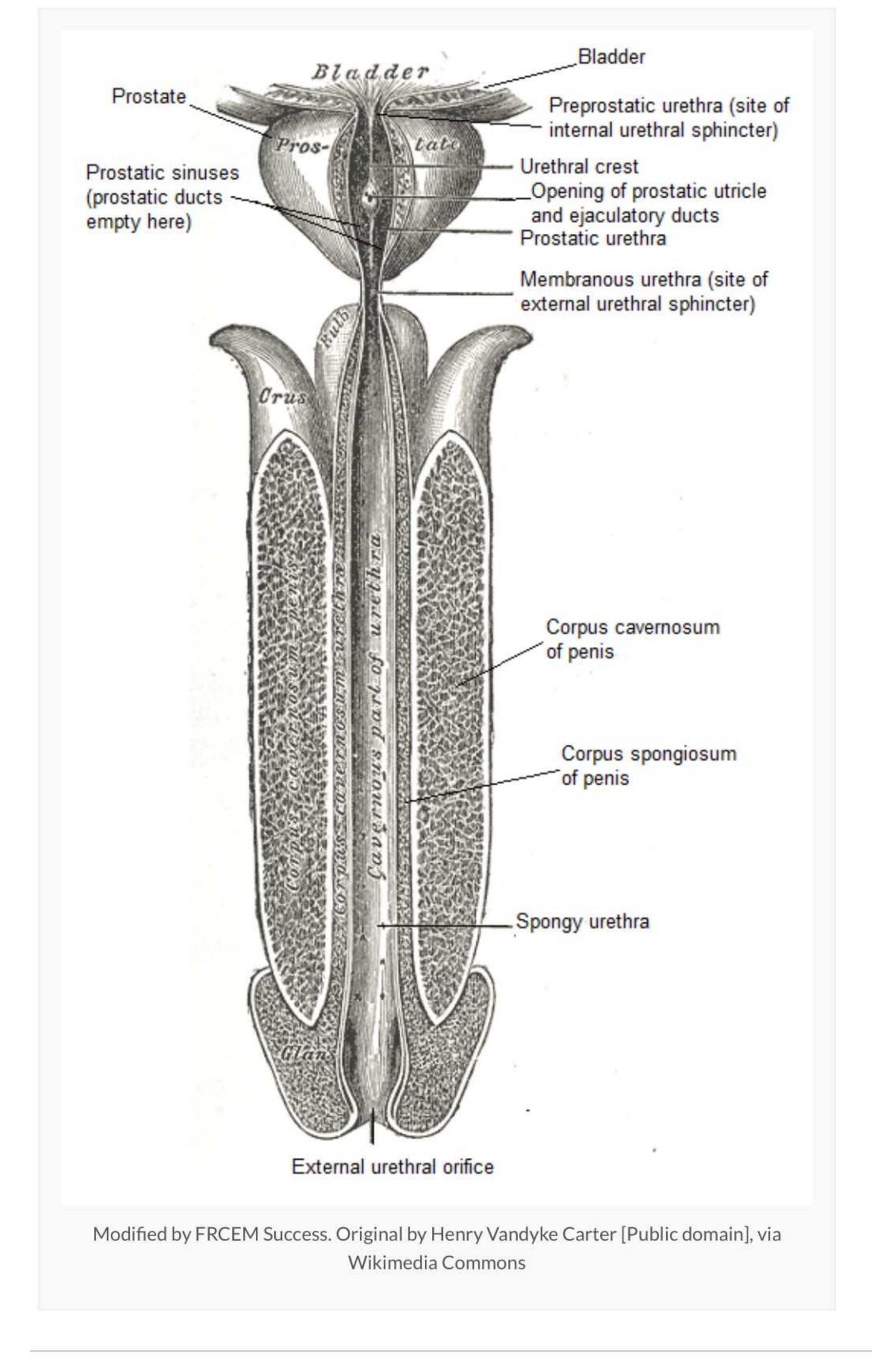
Beginning at the base of the bladder and passing inferiorly through the prostate, the urethra passes through the deep perineal pouch and perineal membrane and immediately enters the root of and travels the length of the penis. The external urethral orifice is the sagittal slit at the end of the penis.

The male urethra bends twice: as it exits the deep perineal pouch it bends forward to course anteriorly in the root of the penis, and when passing from the root to the body of the penis is bends inferiorly.



In men the urethra is long (about 20 cm) and is divided into four parts; preprostatic, prostatic, membranous and spongy:

- The preprostatic part is about 1 cm long, extending from the base of the bladder to the prostate and is associated with the internal urethral sphincter (which prevents retrograde movement of semen into the bladder during ejaculation). • The prostatic part is about 3 – 4 cm long, is the widest part, and is surrounded by the prostate. In
- this region the lumen of the urethra is marked by a longitudinal midline fold of mucosa (the urethral crest). Midway along its length the urethral crest is enlarged, marked by the openings of the prostatic utricle and ejaculatory ducts. The prostatic ducts empty into the prostatic sinuses on either side of the urethral crest. The membranous part is the narrowest part and passes through the urogenital diaphragm.
- During its transit through the pelvic floor, in both men and women, it is surrounded by skeletal muscle of the external urethral sphincter. • The spongy part is the longest part and is surrounded by the corpus spongiosum of the penis. It is
- enlarged to form a bulb at the base of penis and again at the end. The bulbourethral glands open into the bulb of the spongy urethra.



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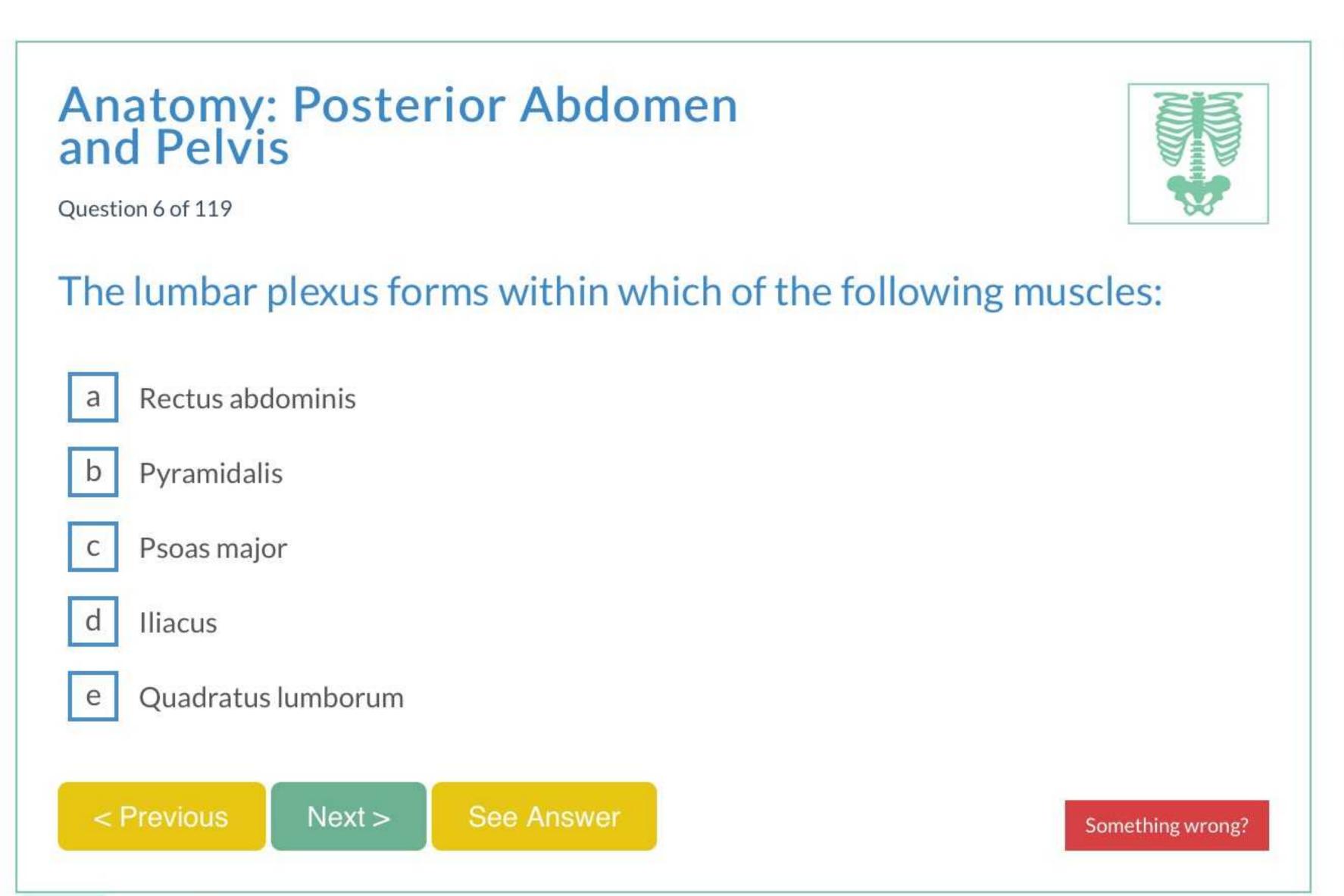
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# Anatomy: Posterior Abdomen and Pelvis

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The lumbar plexus forms within which of the following muscles:

- a) Rectus abdominis 💢
- b) Pyramidalis c) Psoas major

d) Iliacus

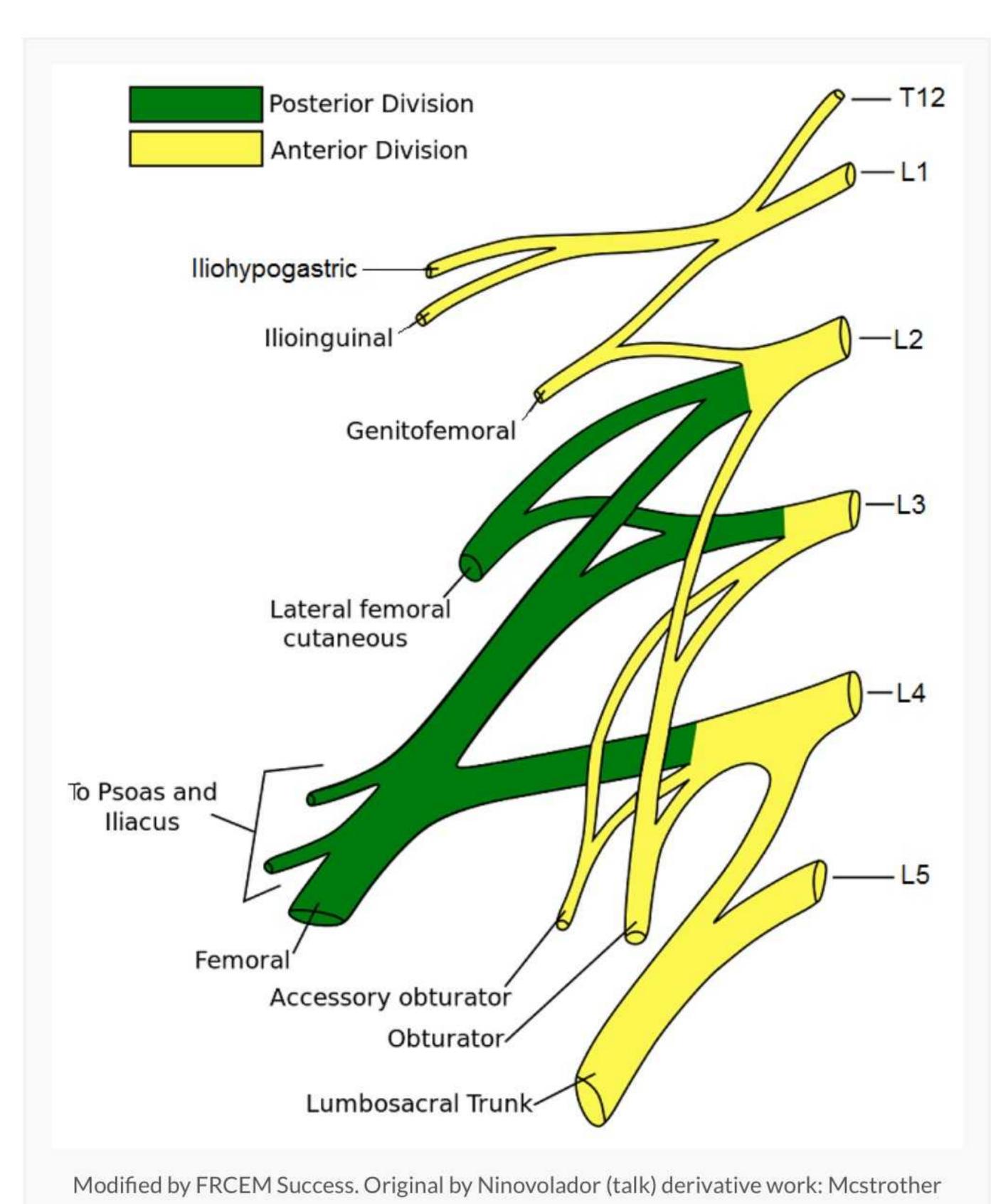
e) Quadratus lumborum

## Answer

The lumbar plexus forms within the substance of the psoas major muscle, anterior to its attachment to the transverse processes of the lumbar vertebrae.

## Notes

The lumbar plexus is formed by the anterior rami of nerves L1 – L3 and most of the anterior ramus of L4. It also receives a contribution from the T12 (subcostal) nerve. The lumbar plexus forms within the substance of the psoas major muscle, anterior to its attachment to the transverse processes of the lumbar vertebrae.



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## Lumbar nerves

Nerve	Spinal segment	Motor function	Sensory function
Iliohypogastric nerve	L1	Internal oblique and transversus abdominis	Posterolateral gluteal skin and skin in pubic region
Ilioinguinal nerve	L1	Internal oblique and transversus abdominis	Skin in upper medial thigh, and either skin over root of penis and anterior scrotum or mons pubis and labium majus
Genitofemoral nerve	L1, L2	Male cremasteric muscle	Skin of anterior scrotum or skin of mons pubis and labium majus (genital branch), skin of upper anterior thigh (genitofemoral nerve)
Lateral cutaneous nerve of thigh	L2, L3	N/A	Skin on lateral thigh to knee
Obturator nerve	L2 – L4	Obturator externus, gracilis and adductor muscles	Skin on medial aspect of thigh
Femoral nerve	L2 – L4	Iliacus, pectineus, sartorius and quadriceps femoris	Skin on anterior thigh and medial leg

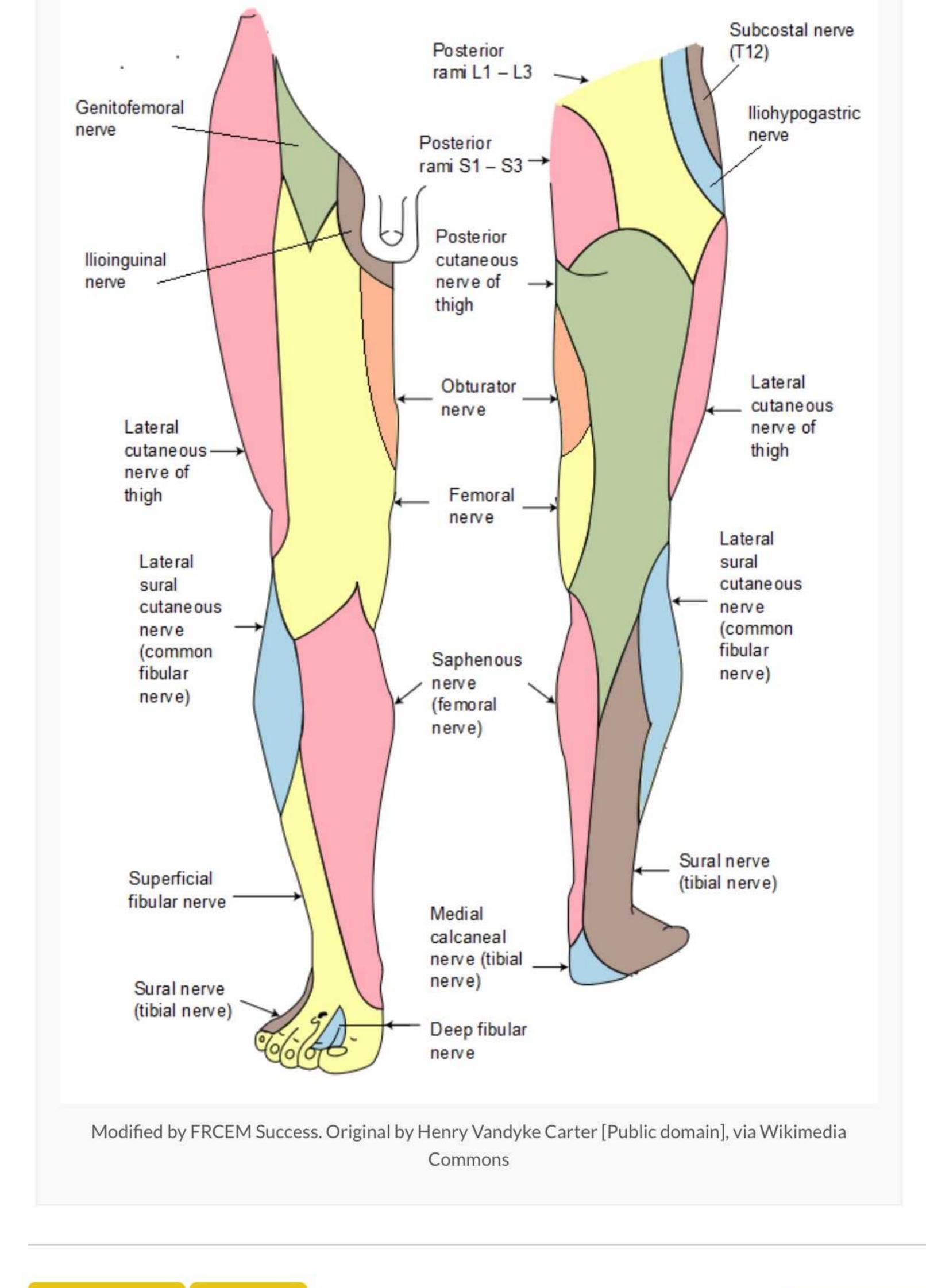
oblique and the transversus abdominis and supplies posterolateral gluteal skin and skin over the pubic region. • The ilioinguinal nerve is formed from the anterior rami of L1. It innervates the internal oblique

• The iliohypogastric nerve is formed from the anterior rami of L1. It innervates the internal

- and transversus abdominis and supplies skin over the upper medial thigh and the external genitalia. • The genitofemoral nerve is formed from the anterior rami of L1 and L2. Its genital branch innervates the male cremaster muscle and supplies skin over the external genitalia and its
- femoral branch supplies skin of the upper anterior thigh. • The lateral cutaneous nerve of the thigh (lateral femoral cutaneous nerve) is formed from the anterior rami of L2 and L3. It supplies skin on the anterolateral thigh to the knee.
- externus and the muscles in the medial compartment of the thigh and supplies skin on the medial aspect of the thigh. • The femoral nerve is formed from the anterior rami of L2 to L4. It innervates the iliacus,

• The obturator nerve is formed from the anterior rami of L2 to L4. It innervates the obturator

pectineus, sartorius and muscles in the anterior compartment of the thigh and supplies skin on the anterior thigh and medial surface of leg.



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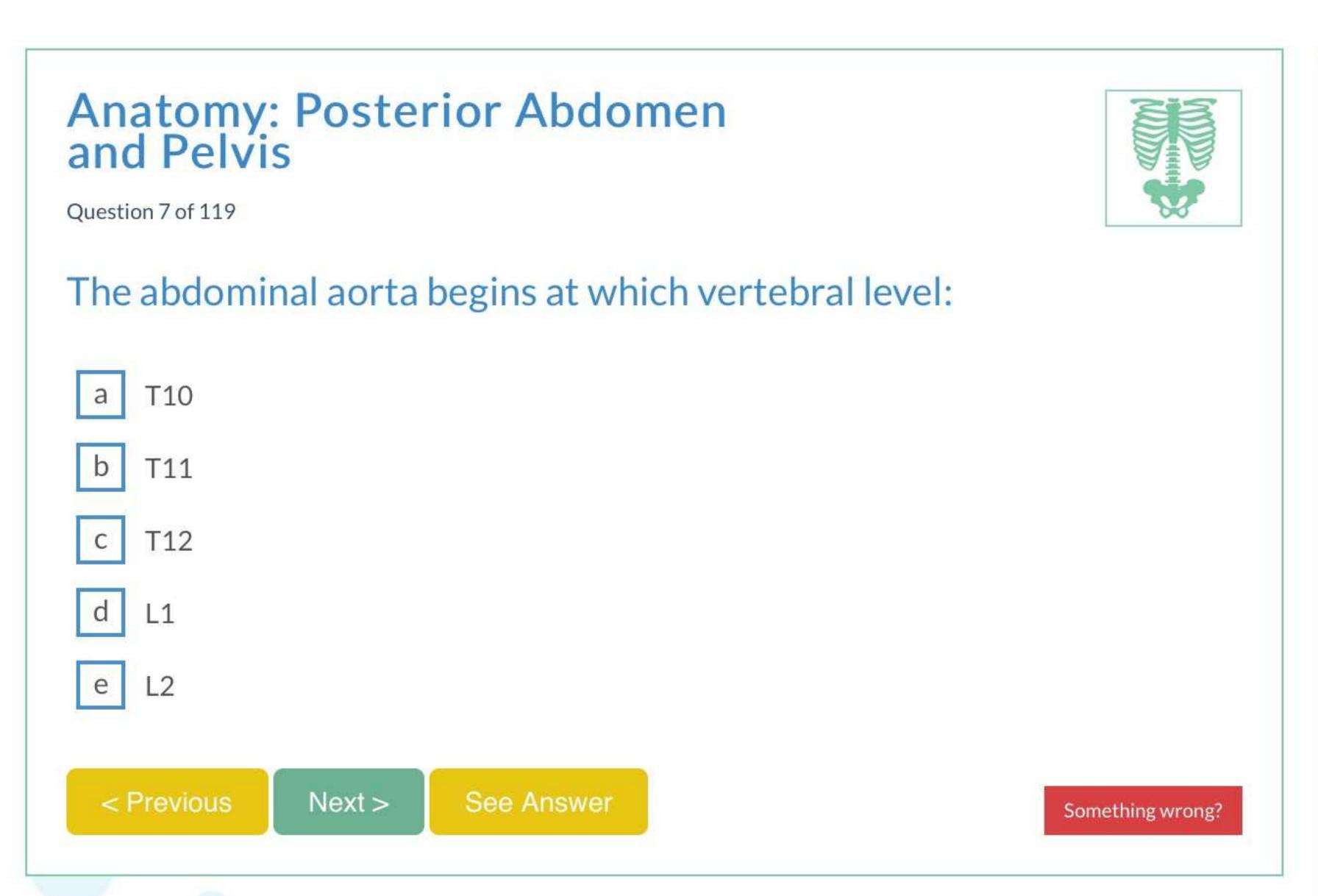
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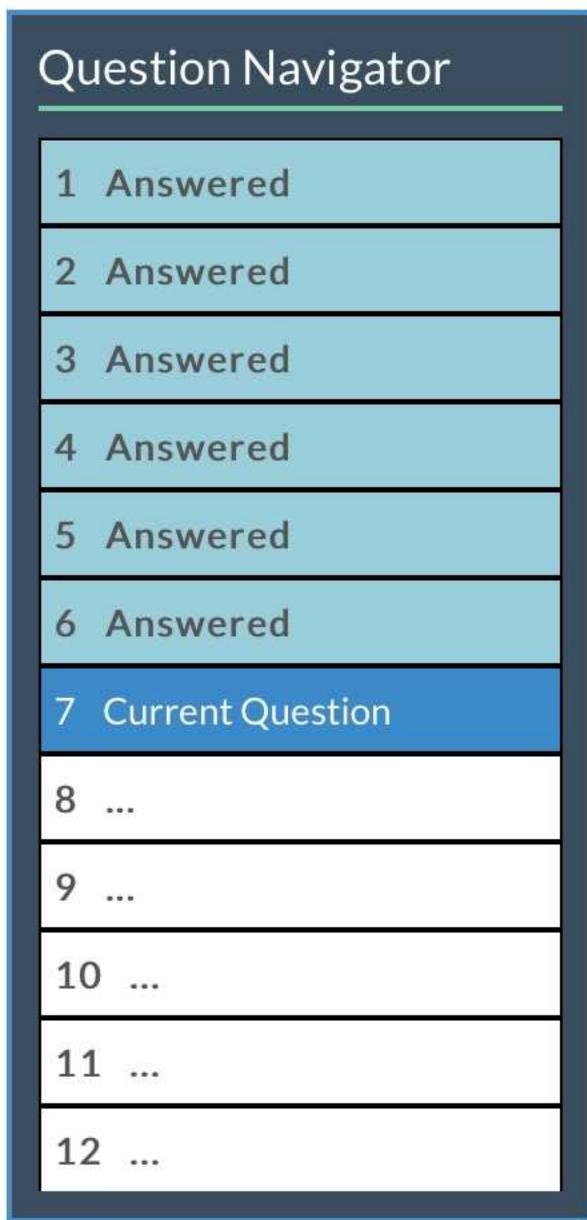
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7 Current Question



MENU

# Anatomy: Posterior Abdomen and Pelvis

Question 7 of 119



The abdominal aorta begins at which vertebral level:

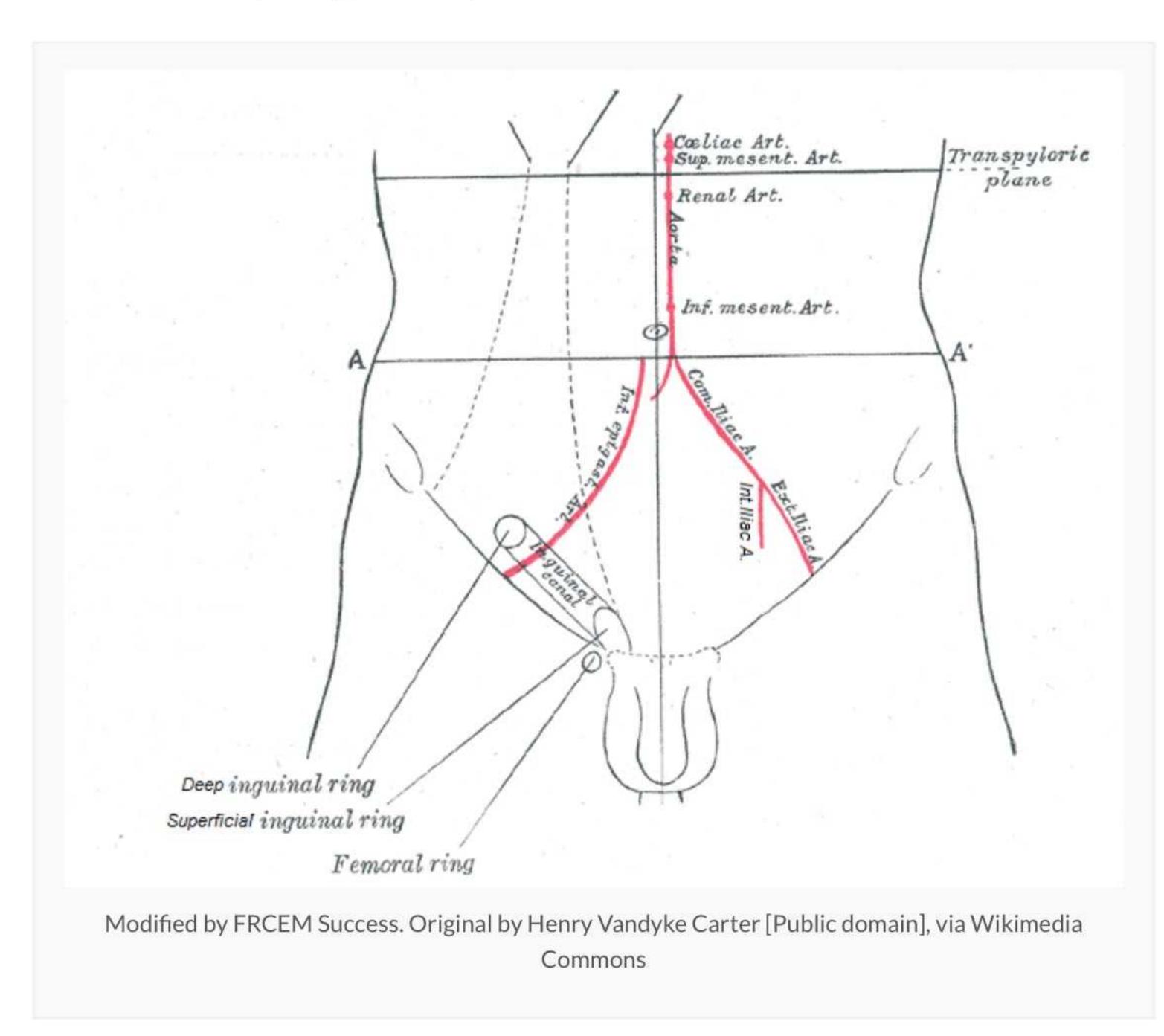
- a) T10 💢
- **b)** T11
- c) T12
- d) L1
- e) L2

#### Answer

The abdominal aorta begins at the aortic hiatus of the diaphragm, anterior to the lower border of vertebra T12.

#### Notes

The abdominal aorta begins at the aortic hiatus of the diaphragm, anterior to the lower border of vertebra T12. It descends through the abdomen, anterior to the vertebral bodies, and by the time it ends at the level of vertebra L4 it is slightly to the left of the midline. The main terminal branches of the abdominal aorta are the two common iliac arteries. This bifurcation can be visualised on the anterior abdominal wall as a point approximately 2.5 cm below the umbilicus.



The abdominal aorta gives rise to:

- three anterior unpaired visceral branches
  - the coeliac trunk supplying the abdominal foregut (T12/L1 vertebral level)
  - the superior mesenteric artery supplying the abdominal midgut (L1 vertebral level)
  - the inferior mesenteric artery supplying the abdominal hindgut (L3 vertebral level)
- three lateral paired visceral branches
  - the middle suprarenal arteries
  - the renal arteries (L1/L2 vertebral level)
  - the gonadal arteries
- posterior parietal branches
  - the inferior phrenic arteries (paired)
  - the lumbar arteries (paired)
  - the median sacral artery (single)
- two terminal branches
  - left common iliac artery
  - right common iliac artery

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# Anatomy: Posterior Abdomen and Pelvis

Question 8 of 119

A 50 year old man complains of lumps in his groin and is found to have painless superficial inguinal lymphadenopathy. Lymph node biopsy demonstrates malignant cells, which of the following sites is most likely the primary source of carcinoma:

- Prostate
- Bladder
- Anal canal
- Testes
- Sigmoid colon

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See Answer

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# Anatomy: Posterior Abdomen and Pelvis

Question 8 of 119

A 50 year old man complains of lumps in his groin and is found to have painless superficial inguinal lymphadenopathy. Lymph node biopsy demonstrates malignant cells, which of the following sites is most likely the primary source of carcinoma:

- a) Prostate X
- b) Bladder
- c) Anal canal
- d) Testes
- e) Sigmoid colon

#### Answer

A malignancy of the anal canal below the pectinate line would drain into the superficial inguinal lymph nodes. The internal iliac nodes receive drainage from the rectum, uterus, prostate gland, bladder and anal canal above the pectineal line. The testes, although located in the scrotum, due to their pattern of developmental descent, drain into the lumbar nodes. The sigmoid colon drains to the inferior mesenteric lymph nodes.

#### Notes

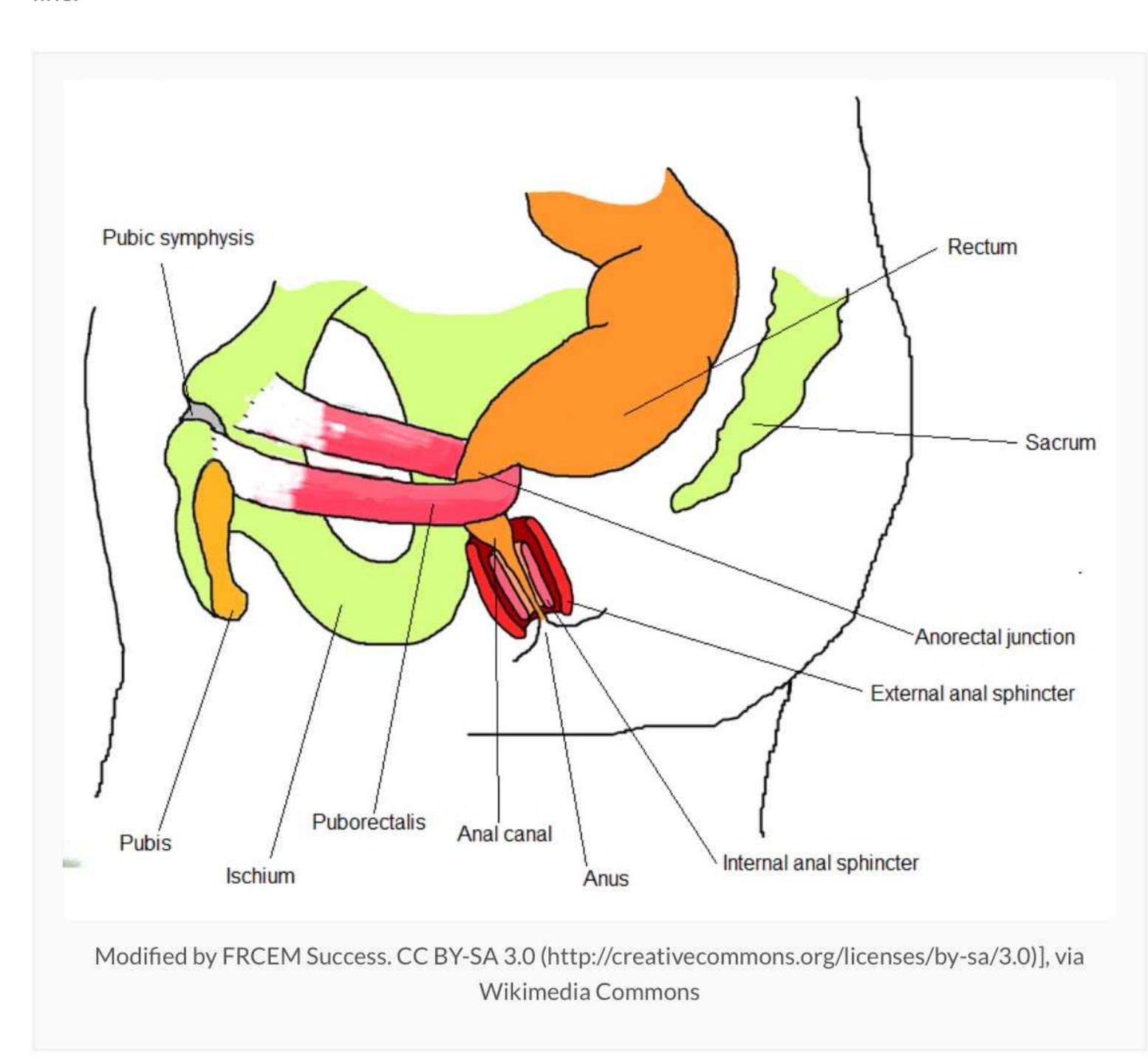
The anal canal is the last 4 cm of the adult gastrointestinal tract and begins at the terminal end of the rectal ampulla, where it narrows at the pelvic floor.

The anorectal junction is pulled forward by the action of the puborectalis muscle (part of the pelvic floor) and so the anal canal moves in a posterior direction as it passes inferiorly through the pelvic floor.

As it passes through the pelvic floor, it is surrounded along its entire length by the internal (involuntary) and external anal sphincters (voluntary), which normally keep it closed.

The anal canal terminates as the anus after passing through the perineum.

The anal canal is divided into the upper two-thirds and the lower one-third by the pectinate (dentate) line.



## **Defecation**

Defecation is initiated by distension of the rectal ampulla which activates visceral afferent impulses transmitted to the spinal cord by the pelvic splanchnic nerve. Parasympathetic stimulation increases peristalsis and relaxes the internal anal sphincter, facilitating defecation. Sympathetic stimulation causes a decrease in peristalsis, and maintains tone in the internal anal sphincter, inhibiting defecation.

To facilitate defecation:

- Intra-abdominal pressure is increased by breath-holding and contracting the diaphragm, abdominal muscles and the levator ani muscle
- The puborectalis muscle relaxes, decreasing the angle between the ampulla of the rectum and the upper portion of the anal canal
- The smooth muscle in the wall of the rectum contracts, the internal anal sphincter relaxes, and the external anal sphincter relaxes

## **Lymphatics**

Above the dentate line, the anal canal drains to the internal iliac lymph nodes which subsequently drain to the lumbar (aortic) nodes.

Below the dentate line the anal canal drains to the superficial inguinal nodes. These nodes have efferent vessels that drain primarily into the external iliac nodes and ultimately to the lumbar (aortic) nodes.

## **Innervation**

Above the dentate line, the anal canal receives innervation from the autonomic nervous system via the inferior hypogastric plexus.

Below the dentate line it is innervated by the somatic fibres of the pudendal nerve (S2 - S4) which innervates the external anal sphincter and most of the skin over the perineum.

The anococcygeal nerves originate from the coccygeal plexus (S4 - C0) and innervate skin in the anal triangle of the perineum.

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# Anatomy: Posterior Abdomen and Pelvis

Question 9 of 119

The cutaneous supply of the scrotum is derived primarily from which of the following spinal nerve roots.

- T10 L1
- b L5, S1
- L2 L4
- S1 S4
- L1, S2 S3

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See Answer

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# Anatomy: Posterior Abdomen and Pelvis

Question 9 of 119

The cutaneous supply of the scrotum is derived primarily from which of the following spinal nerve roots.

a) T10 - L1 🔏

**b)** L5, S1

c) L2 - L4

**d)** S1 - S4 e) L1, S2 - S3

#### Answer

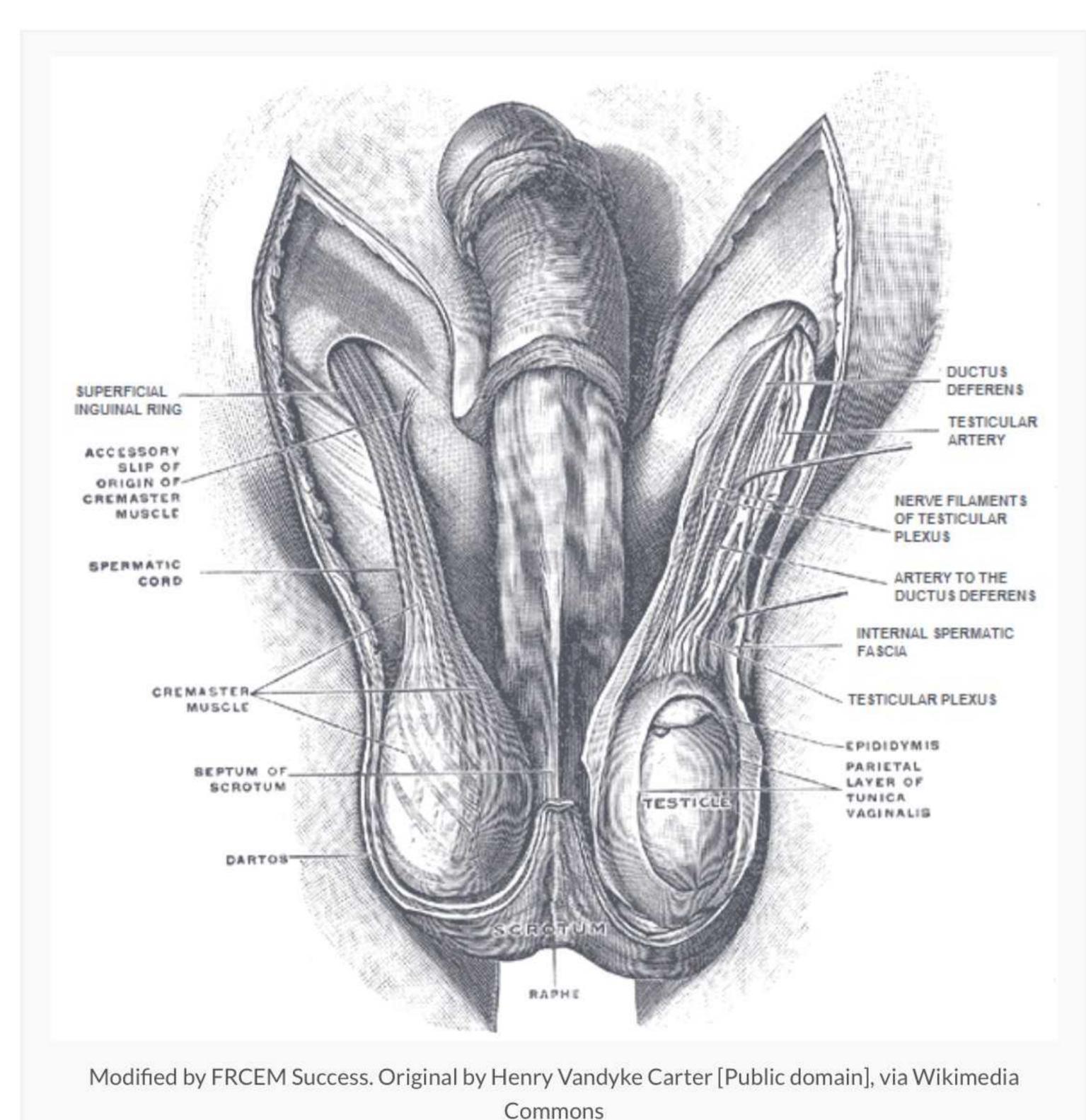
The scrotum is innervated by nerves derived primarily from spinal roots L1 and S2 - S3:

- anterolaterally by the genital branch of the genitofemoral nerve (L1 L2)
- anteriorly by scrotal branches of the ilioinguinal nerve (L1)
- posteriorly by scrotal branches of the perineal nerve of the pudendal nerve (S3)
- inferiorly by perineal branches of the posterior femoral cutaneous nerve (S2)

## Notes

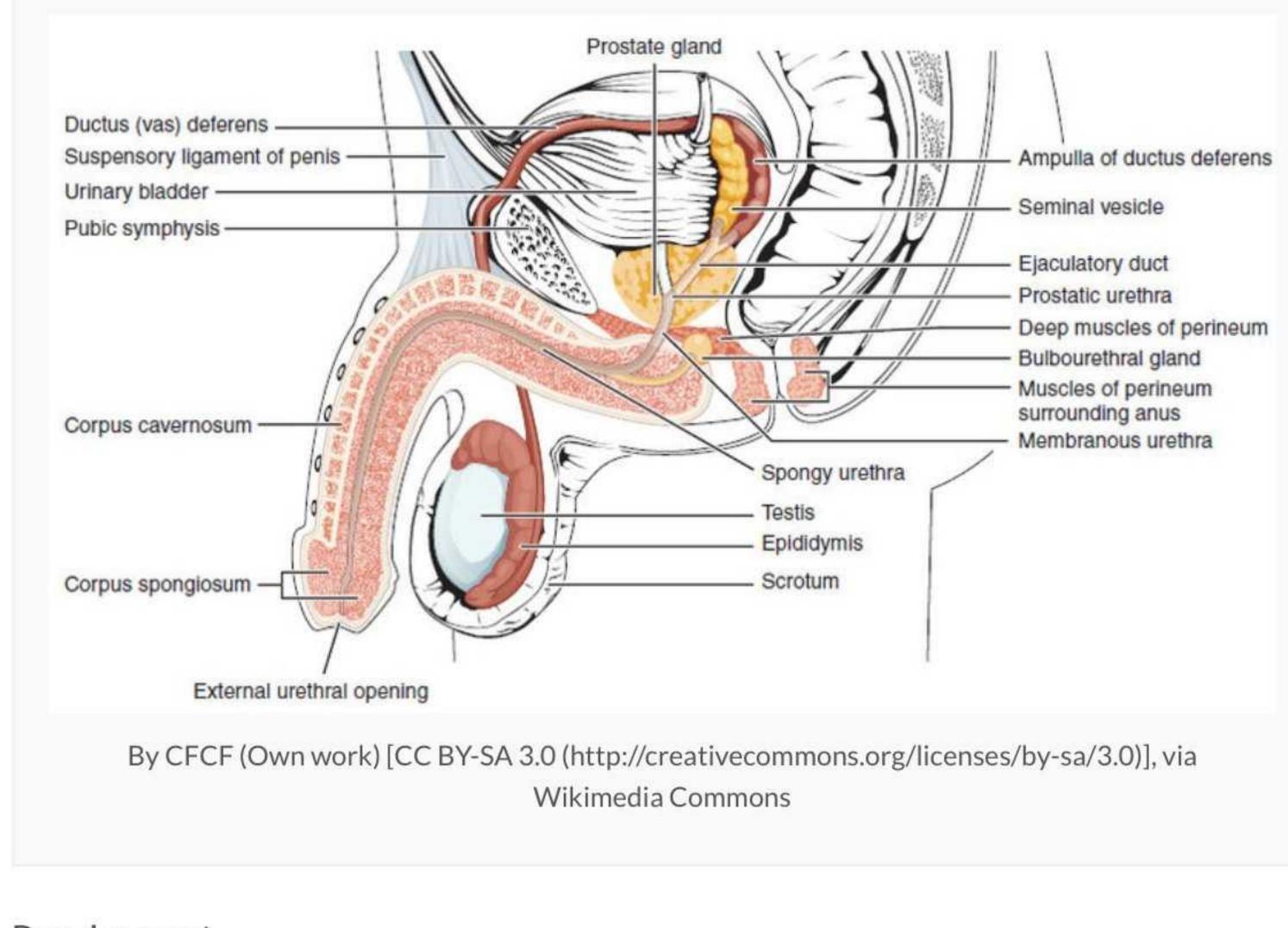
The testis and epididymis are suspended in the scrotum by the spermatic cord. The inferior pole of the testis is attached to the scrotal wall by the scrotal ligament, which is the remnant of the gubernaculum testis.

Each testis is composed of seminiferous tubules (which produce spermatozoa) and interstitial tissue (which secretes testosterone) surrounded by a thick connective tissue capsule, the tunica albuginea. The spermatozoa collects in the epididymis, the tail of which is continuous with the ductus deferens, which transports the spermatozoa to the ejaculatory ducts in the pelvic cavity.



## Ductus deferens

The ductus deferens ascends in the scrotum as part of the spermatic cord and passes through the inguinal canal in the anterior abdominal wall. After exiting the inguinal canal through the deep inguinal ring, it enters the pelvic cavity and descends medially on the pelvic wall, deep to the peritoneum, and crosses the ureter posterior to the bladder. It continues inferomedially along the base of the bladder, anterior to the rectum, almost to the midline where it is joined by the duct of the seminal vesicle to form the ejaculatory duct. The ejaculatory duct penetrates through the prostate gland to connect with the prostatic urethra.



## <u>Development</u>

The testes develop high on the posterior abdominal wall and then descend, normally before birth, through the inguinal canal in the anterior abdominal wall and into the scrotum of the perineum. During the descent, the testes carry their vessels, lymphatics, nerves and ductus deferens with them. The spermatic cord is the tube-shaped connection between the pouch in the scrotum and the abdominal wall.

The sides and anterior aspect of the testis are covered by the serous tunica vaginalis, derived from the embryonic processus vaginalis which is originally connected to the abdominal cavity. Normally after testicular descent, the connection closes, leaving a fibrous remnant. Failure of closure can result in the development of an indirect inguinal hernia.

## Blood supply

The testes receive their arterial supply from the testicular artery, direct branch of the abdominal aorta, which travels in the spermatic cord.

## Lymphatics

The lymph drainage of the testes is to the lumbar (para-aortic) nodes in the abdomen, in contrast to that of the scrotum which drains to the superficial inguinal nodes.

## **Innervation**

The testes receive their autonomic nerve supply from the testicular plexus. Visceral afferent fibres usually follow the sympathetic fibres to spinal cord levels T10 - L1; pain is thus referred to the

The scrotum is innervated by nerves derived primarily from spinal roots L1 and S2 - S3:

- anterolaterally by the genital branch of the genitofemoral nerve (L1 L2) anteriorly by scrotal branches of the ilioinguinal nerve (L1)
- posteriorly by scrotal branches of the perineal nerve of the pudendal nerve (S3)
- inferiorly by perineal branches of the posterior femoral cutaneous nerve (S2)

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periumbilical region, suprapubic region and groin.

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# Anatomy: Posterior Abdomen and Pelvis

Question 10 of 119



- The bladder drains into the ureters.
- The ureters are continuously superiorly with the renal medulla.
- The ureters descend on the medial aspect of the psoas major muscles.
- The ureters are intraperitoneal structures.
- The left ureter lies in close proximity to the appendix.

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See Answer

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Anatomy: Posterior Abdomen and Pelvis

Question 10 of 119



Regarding the ureters, which of the following statements is CORRECT:

- The bladder drains into the ureters.
- b) The ureters are continuously superiorly with the renal medulla.
- c) The ureters descend on the medial aspect of the psoas major muscles.
- d) The ureters are intraperitoneal structures.
- e) The left ureter lies in close proximity to the appendix.

#### Answer

The ureters are muscular tubes that transport urine from the kidneys to the bladder. They are continuous superiorly with the renal pelvis at the ureteropelvic junction. Inferior to the ureteropelvic junction, the ureters descend retroperitoneally on the medial aspect of the psoas major muscle, anterior to the tips of the transverse processes of the lower lumbar vertebrae. The right ureter lies in close proximity to the appendix and be irritated in inflammation resulting in urinary symptoms.

#### Notes

The ureters are muscular tubes that transport urine from the kidneys to the bladder. They are continuous superiorly with the renal pelvis at the ureteropelvic junction (at the level of the renal hilum, vertebra L1).

#### Anatomical course and relations

Inferior to the ureteropelvic junction, the ureters descend retroperitoneally on the medial aspect of the psoas major muscle, anterior to the tips of the transverse processes of the lower lumbar vertebrae. The ureters cross the pelvic brim anterior to the bifurcation of the common iliac arteries to enter the pelvic cavity and continue their journey down the lateral pelvic walls.

Within the pelvic cavity, the ureters are crossed by the uterine artery lateral to the cervix in women, and by the ductus deferens just posterior to the bladder in men.

At the level of the ischial spines, they turn anteromedially, moving in a transverse plane towards the bladder. The ureters enters obliquely through the base of the bladder at the level of the pubic tubercle.

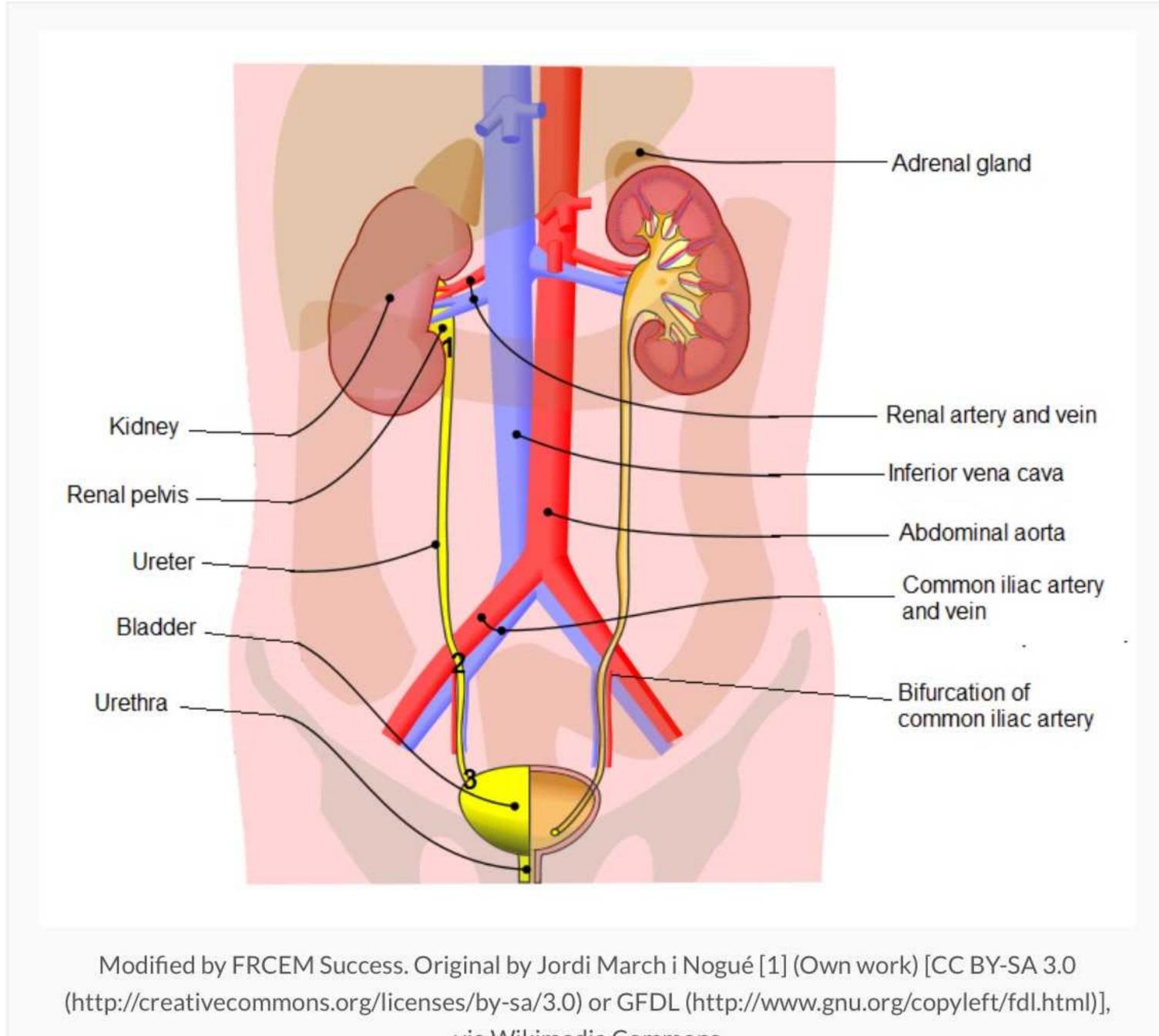
The right ureter lies in close relation to the appendix, and thus be irritated in acute appendicitis causing urinary frequency.

## Constrictions

At three points along their course, the ureters are constricted;

- the first point is at the ureteropelvic junction
- the second point is where the ureters cross the pelvic brim
- the third point is where the ureters enter the wall of the bladder.

Kidneys stones can become lodged at these constrictions.



via Wikimedia Commons

## Renal colic pain

Visceral afferent fibres from the ureters enter the spinal cord at T11 - L2, with ureteric pain (usually from ureteric distension) thus referred to the dermatomes supplied by T11 - L2; the posterior and lateral abdominal wall below the ribs and above the iliac crest, the pubic region, the scrotum in males, the labia majora in females and the proximal anterior aspect of the thigh (loin to groin pain).

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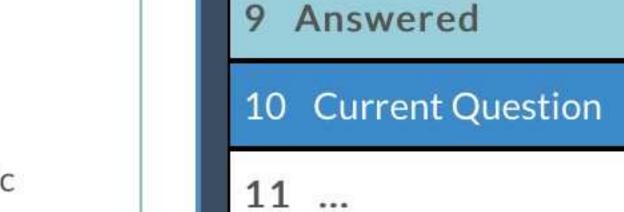
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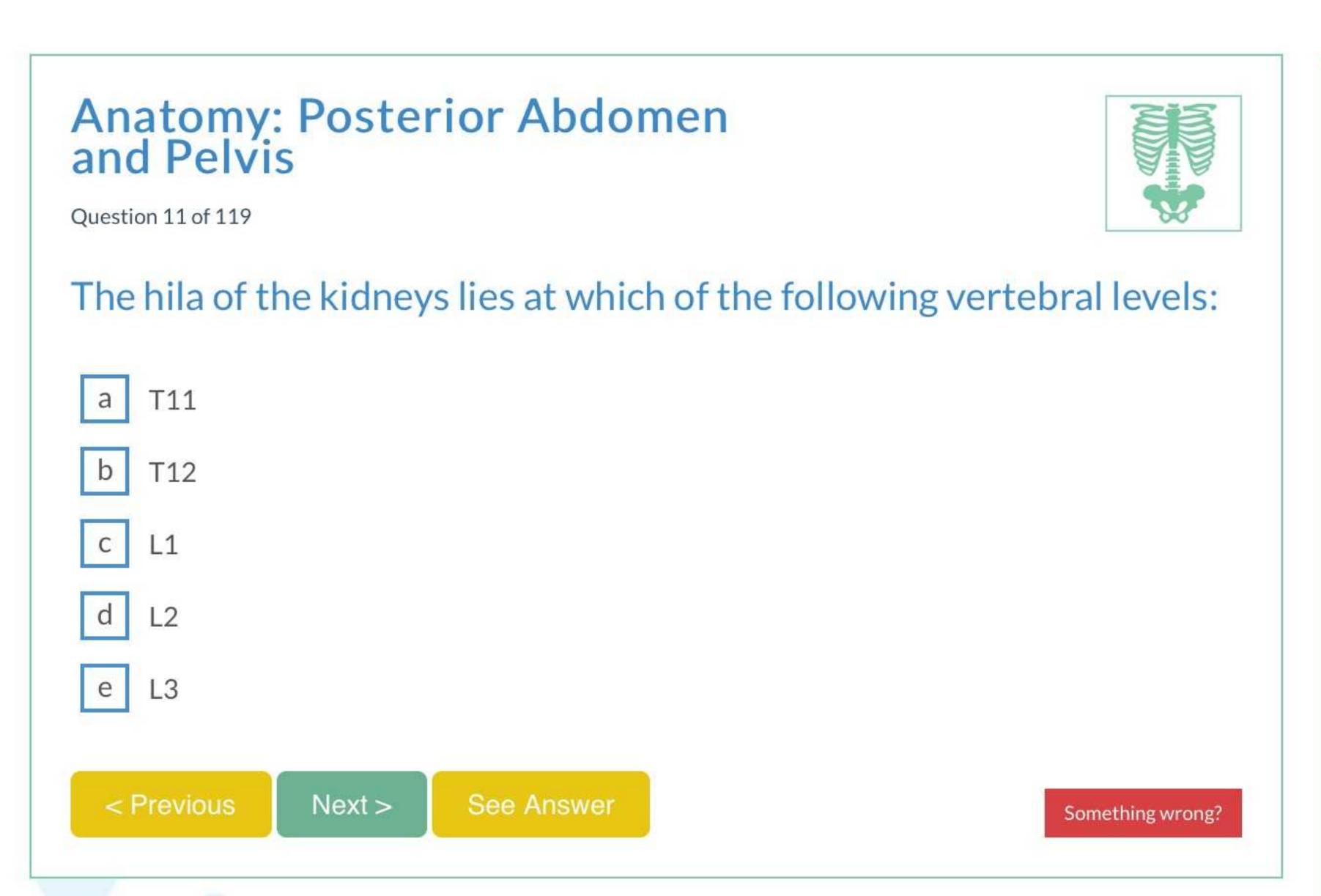


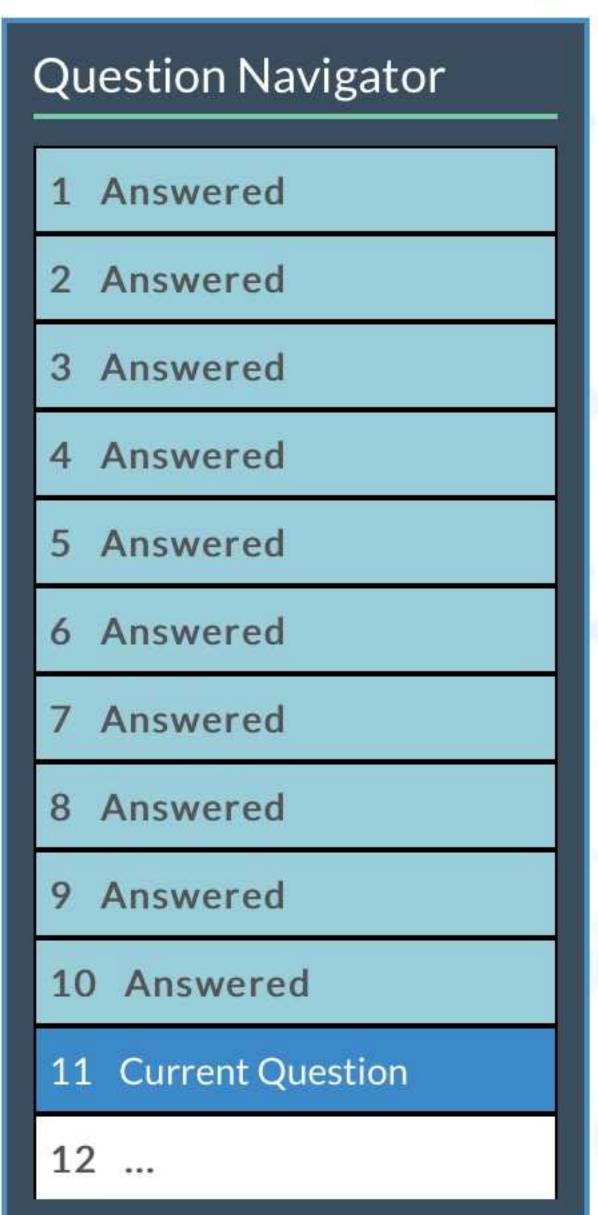


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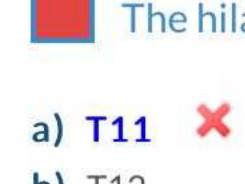
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# Anatomy: Posterior Abdomen and Pelvis

Question 11 of 119

The hila of the kidneys lies at which of the following vertebral levels:



**b)** T12 c) L1

d) L2 e) L3

## Answer

The hila of the kidneys and the beginning of the ureters are at the level of the L1 vertebra.

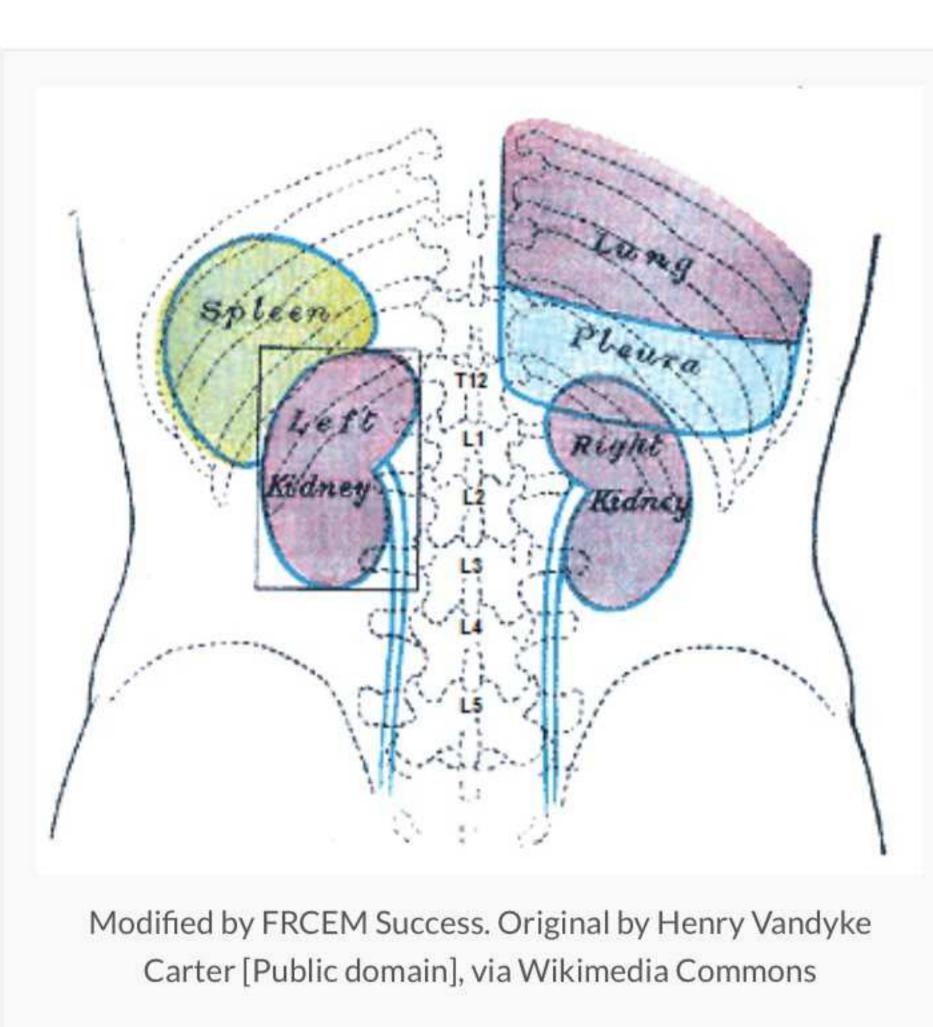
## Notes

The kidneys are retroperitoneal organs. They lie in the extraperitoneal connective tissue immediately lateral to the vertebral column in the upper left and right abdominal quadrants.

Viscera	Kidney			
Surface marking	Extend between vertebrae T12 – L3, left kidney slightly higher than right, renal hila at vertebral level L1			
Anterior relations	RIGHT: right adrenal gland, liver, second part of duodenum, right colic flexure, segment of small intestine. LEFT: left adrenal gland, spleen, pancreas, stomach, left colic flexure and descending colon, duodenojejunal flexure and coils of small intestine			
Posterior relations	Diaphragm, psoas major, quadratus lumborum and transversus abdominis muscles			
Structure	Each kidney covered by fibrous capsule and surrounded by renal fascia, kidney itself made up of outer renal cortex and inner renal medulla, renal pelvis continuous with ureters			
Blood	Renal artery (branch of abdominal aorta arising at vertebral level L1/L2 posterior the pancreas), divides into segmental arteries to supply renal parenchyma			
Lymphatics	Lumbar (para-aortic) lymph nodes			
Innervation	Via renal plexus, parasympathetic fibres from vagus nerve and sympathetic fibres from thoracic splanchnic nerves			

Surface markings

The position of the kidneys varies with respiration and the position of the body. In the supine position, the kidneys extend from approximately vertebra T12 superiorly to vertebra L3 inferiorly. The left kidney is a little higher than the right, reaching as high as rib 11, compared to rib 12 for the right kidney (because of its relationship with the liver). The hila of the kidneys and the beginning of the ureters are at the level of the L1 vertebra.



## Relations

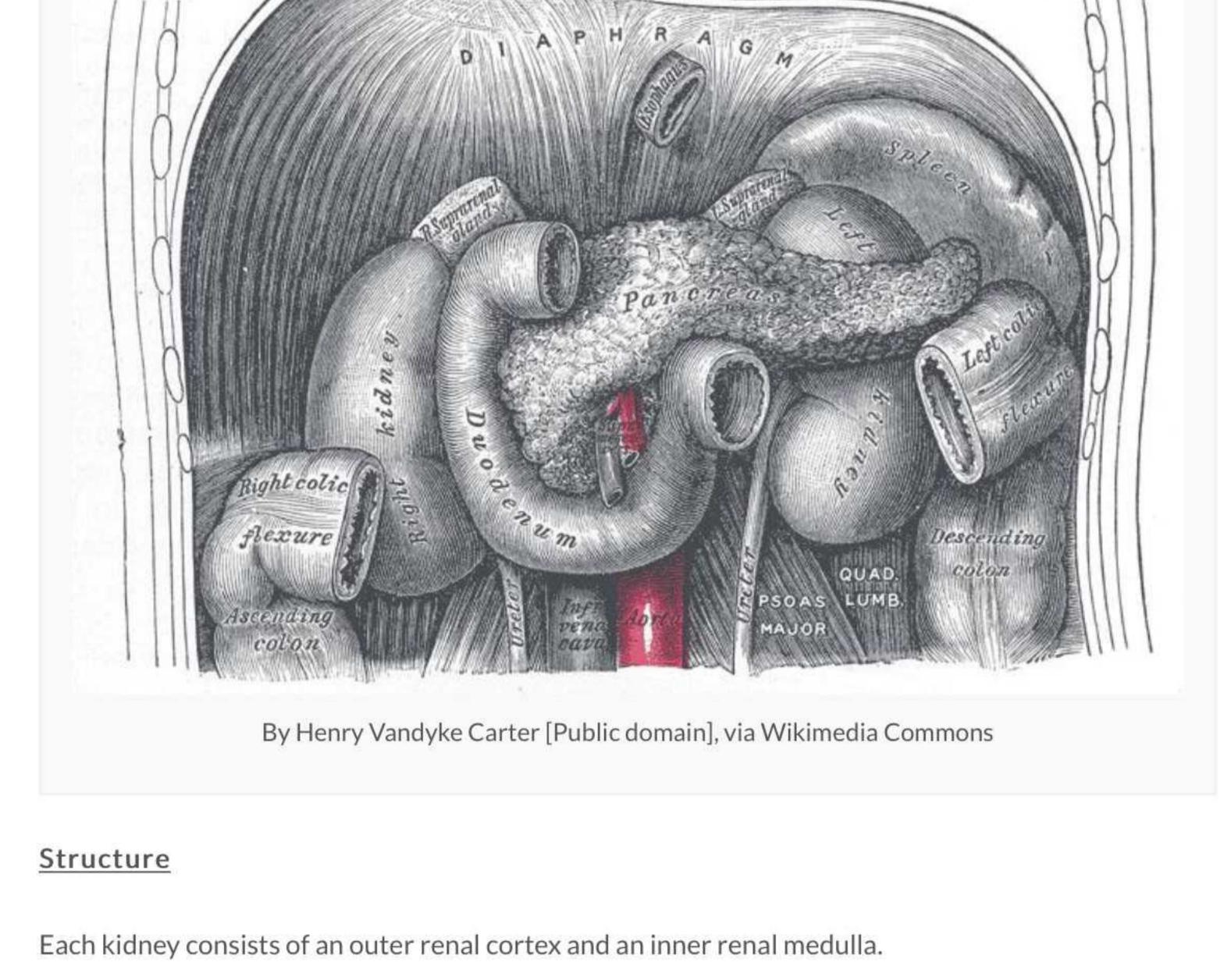
The anterior surface of the right kidney is related to the (superiorly to inferiorly):

- right adrenal gland medially liver
- second part of the duodenum medially,
- right colic flexure laterally a segment of small intestine medially.
- The anterior surface of the left kidney is related to the (superiorly to inferiorly):

left adrenal gland medially

sacs and the costodiaphragmatic recesses also extend posterior to the kidneys.

- spleen laterally
- pancreas
- stomach (the kidney forms part of the stomach bed)
- left colic flexure and descending colon laterally duodenojejunal flexure and coils of small intestine
- Posteriorly both kidneys are related superiorly to the diaphragm and ribs and inferiorly (moving from medial to lateral) the psoas major, quadratus lumborum and transversus abdominis muscles. The pleural



# Extensions of the renal cortex (the renal columns) project into the inner aspect of the kidney, dividing the

Cortical -

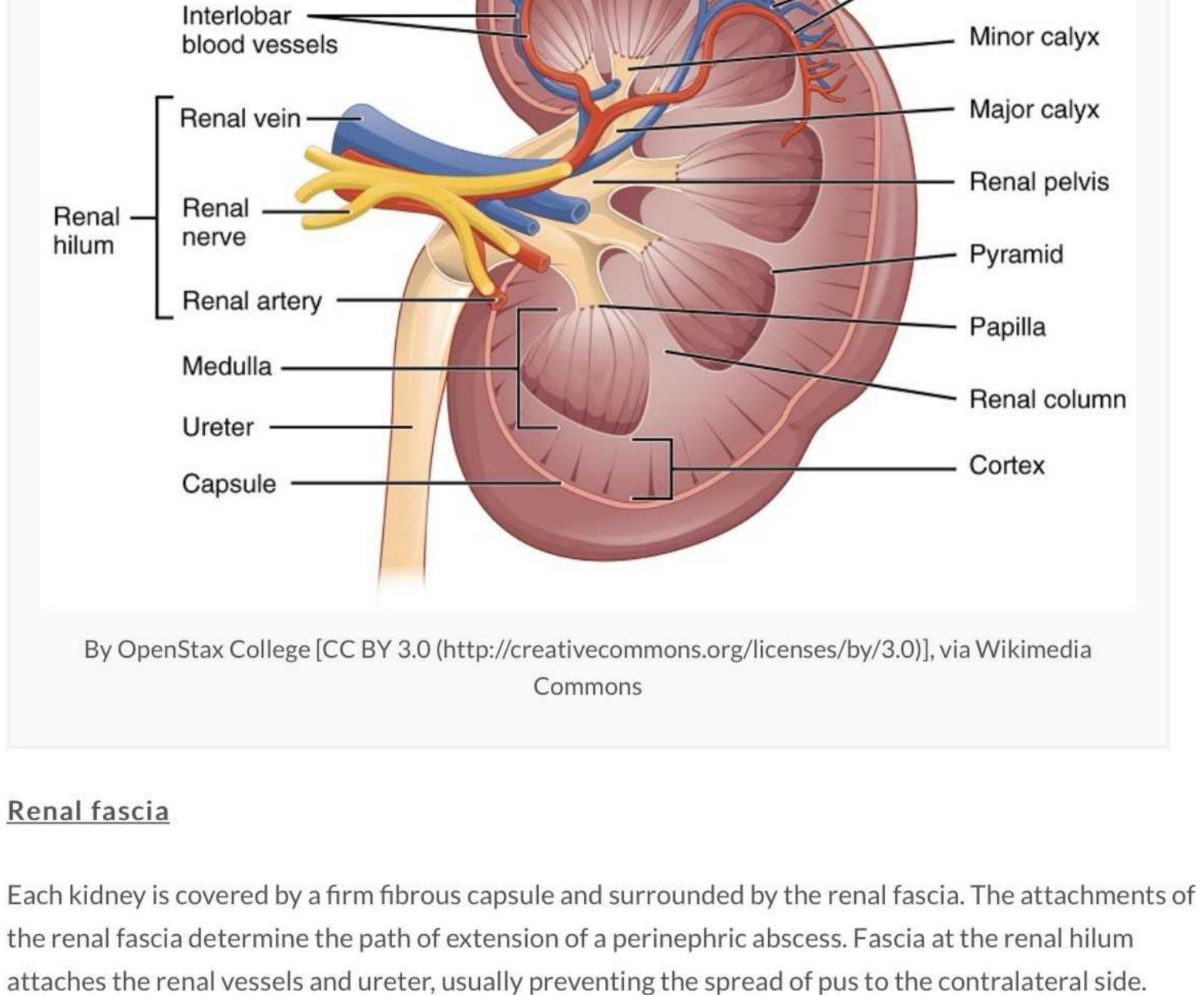
blood vessels

renal medulla into the renal pyramids. The base of the renal pyramids are directed outwards towards the renal cortex, while the apex of each renal pyramid projects inwards towards the renal sinus, a cavity which is occupied by the renal calyces, blood vessels, nerves and fat.

The apical projection of the renal pyramid is surrounded by a minor calyx into which the collecting ducts drain. Several minor calyces unite to form a major calyx, and two or three major calyces unite to form the renal pelvis, which is continuous with the ureter.

Arcuate

blood vessels



However pus from an abscess may force its way into the pelvis between the loosely attached anterior and posterior layers of the renal fascia. **Blood supply** The renal artery arises from the abdominal aorta just inferior to the origin of the superior mesenteric

artery just between vertebrae L1 and L2 and posterior to the pancreas. Each renal artery enters the kidney via the renal hilum, dividing into segmental branches. These branches

The lymphatic drainage is to the lumbar (para-aortic) lymph nodes located at the origin of the renal arteries.

undergo further divisions to supply the renal parenchyma.

**Innervation** 

Lymphatic drainage

The kidneys receive autonomic nerve fibres via the renal plexus which contains parasympathetic fibres

from the vagus nerve and sympathetic fibres from the thoracic splanchnic nerves.

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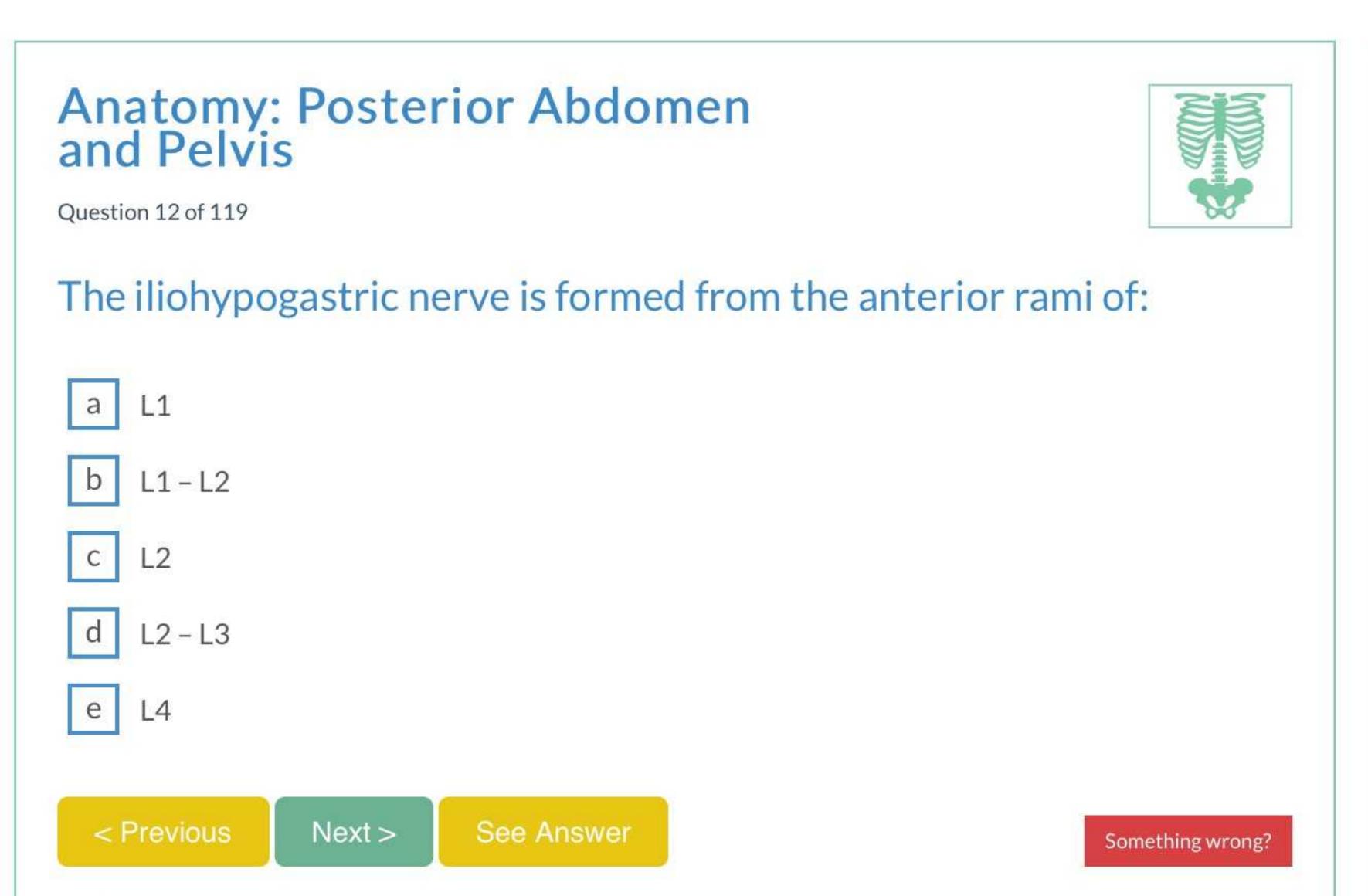


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# Anatomy: Posterior Abdomen and Pelvis

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The iliohypogastric nerve is formed from the anterior rami of:

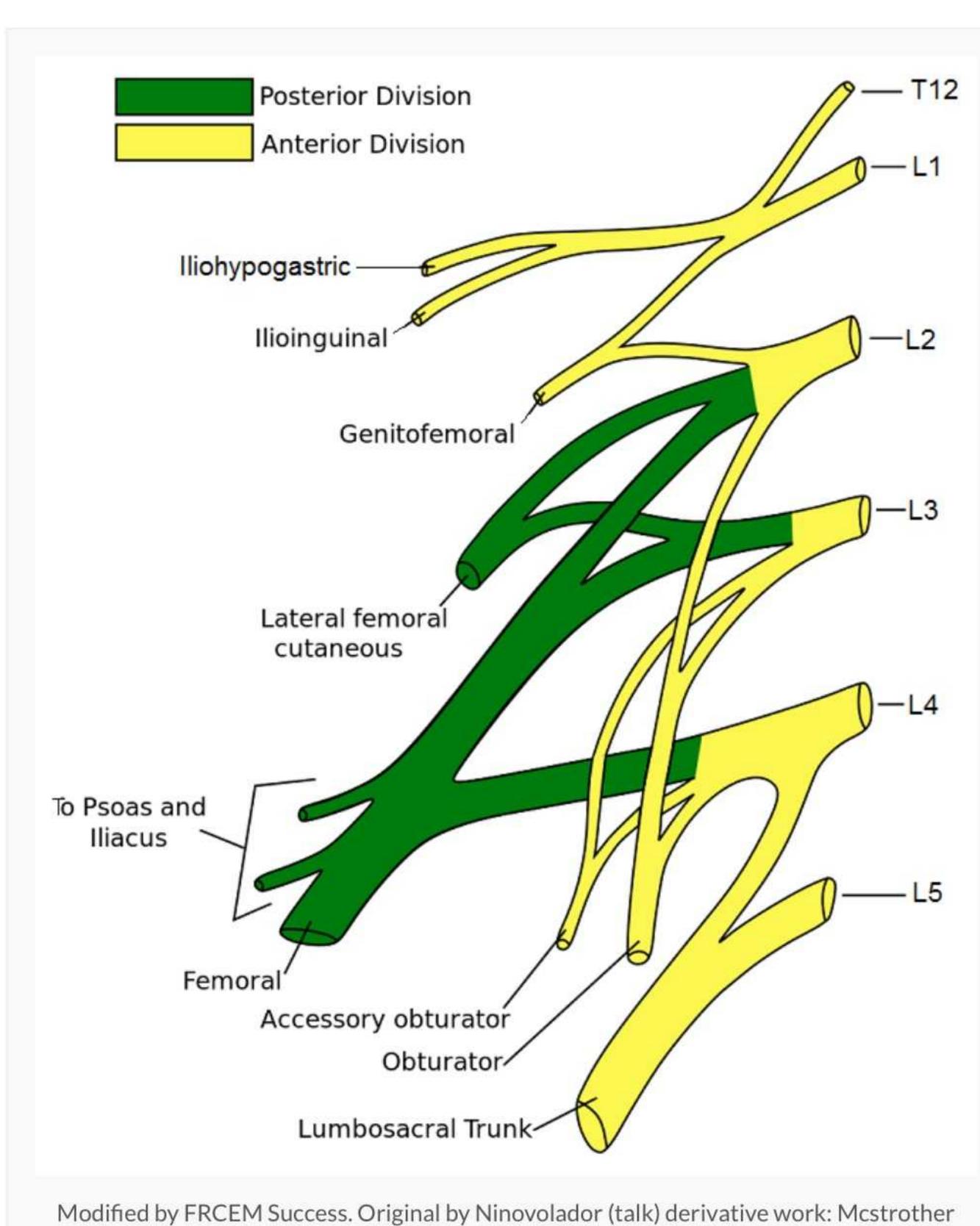
- a) L1 🗸
- **b)** L1 L2
- c) L2
- **d)** L2 L3
- e) L4

## Answer

The iliohypogastric nerve is formed from the anterior rami of L1. It innervates the internal oblique and the transversus abdominis muscles and supplies posterolateral gluteal skin and skin over the pubic region.

## Notes

The lumbar plexus is formed by the anterior rami of nerves L1 – L3 and most of the anterior ramus of L4. It also receives a contribution from the T12 (subcostal) nerve. The lumbar plexus forms within the substance of the psoas major muscle, anterior to its attachment to the transverse processes of the lumbar vertebrae.



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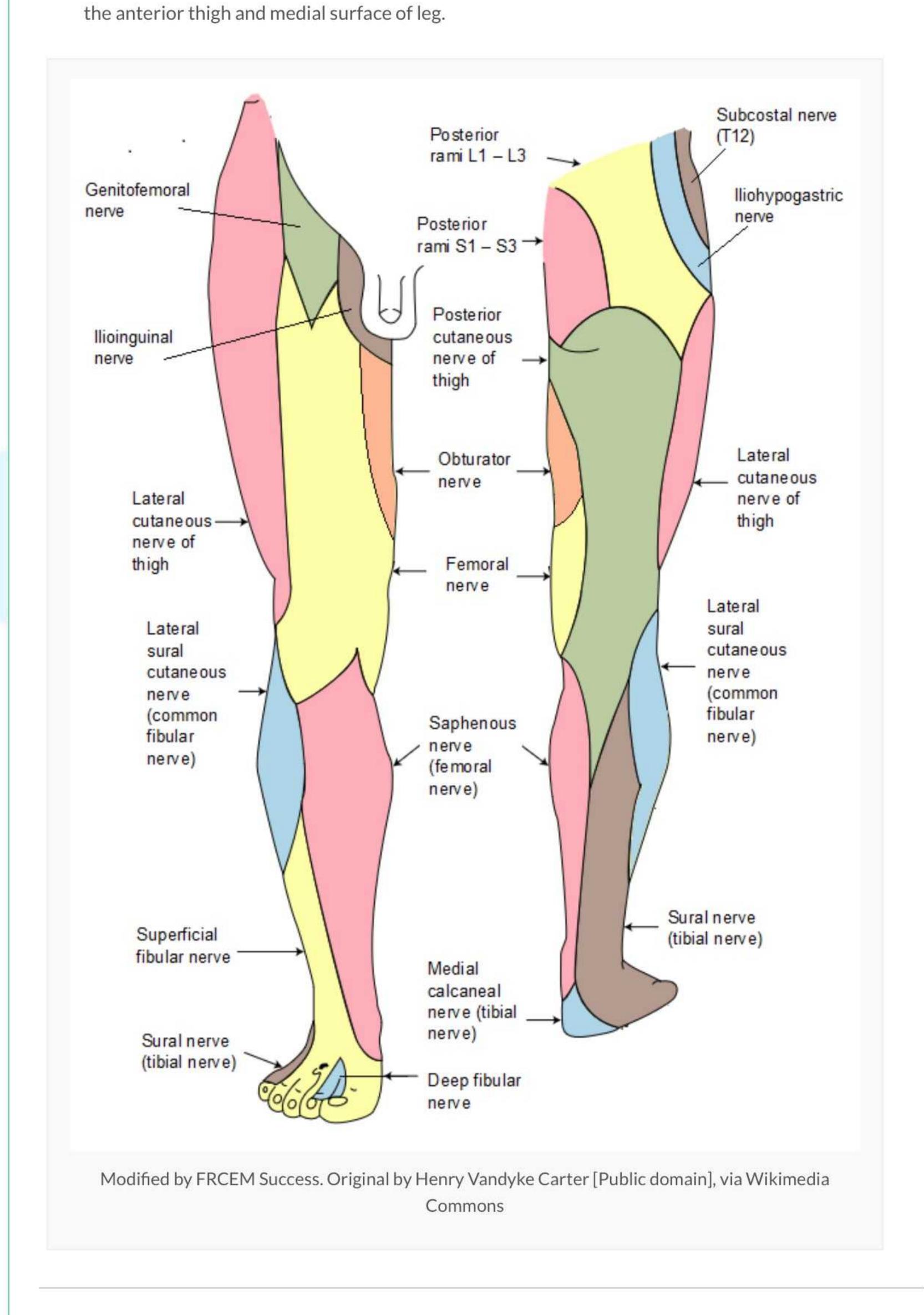
Lumbar nerves

Nerve	Spinal segment	Motor function	Sensory function
Iliohypogastric nerve	L1	Internal oblique and transversus abdominis	Posterolateral gluteal skin and skin in pubic region
Ilioinguinal nerve	L1	Internal oblique and transversus abdominis	Skin in upper medial thigh, and either skin over root of penis and anterior scrotum or mons pubis and labium majus
Genitofemoral nerve	L1, L2	Male cremasteric muscle	Skin of anterior scrotum or skin of mons pubis and labium majus (genital branch), skin of upper anterior thigh (genitofemoral nerve)
Lateral cutaneous nerve of thigh	L2, L3	N/A	Skin on lateral thigh to knee
Obturator	L2 – L4	Obturator externus, gracilis and adductor muscles	Skin on medial aspect of thigh
Femoral nerve	L2 – L4	Iliacus, pectineus, sartorius and quadriceps femoris	Skin on anterior thigh and medial leg

oblique and the transversus abdominis and supplies posterolateral gluteal skin and skin over the pubic region. • The ilioinguinal nerve is formed from the anterior rami of L1. It innervates the internal oblique

• The iliohypogastric nerve is formed from the anterior rami of L1. It innervates the internal

- and transversus abdominis and supplies skin over the upper medial thigh and the external genitalia. • The genitofemoral nerve is formed from the anterior rami of L1 and L2. Its genital branch
- innervates the male cremaster muscle and supplies skin over the external genitalia and its femoral branch supplies skin of the upper anterior thigh. • The lateral cutaneous nerve of the thigh (lateral femoral cutaneous nerve) is formed from the
- anterior rami of L2 and L3. It supplies skin on the anterolateral thigh to the knee. • The obturator nerve is formed from the anterior rami of L2 to L4. It innervates the obturator externus and the muscles in the medial compartment of the thigh and supplies skin on the medial
- aspect of the thigh. • The femoral nerve is formed from the anterior rami of L2 to L4. It innervates the iliacus, pectineus, sartorius and muscles in the anterior compartment of the thigh and supplies skin on



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# Anatomy: Posterior Abdomen and Pelvis

Question 13 of 119

Visceral afferent fibres from the testes usually travel to which of the following spinal cord levels:

- T10 L1
- T9 T12
- L1 L3
- L2 L4
- S3, S4

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See Answer

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# Anatomy: Posterior Abdomen and Pelvis

Question 13 of 119

Visceral afferent fibres from the testes usually travel to which of the following spinal cord levels:

- a) T10 L1
- **b)** T9 T12 c) L1 - L3
- **d)** L2 L4

e) S3, S4

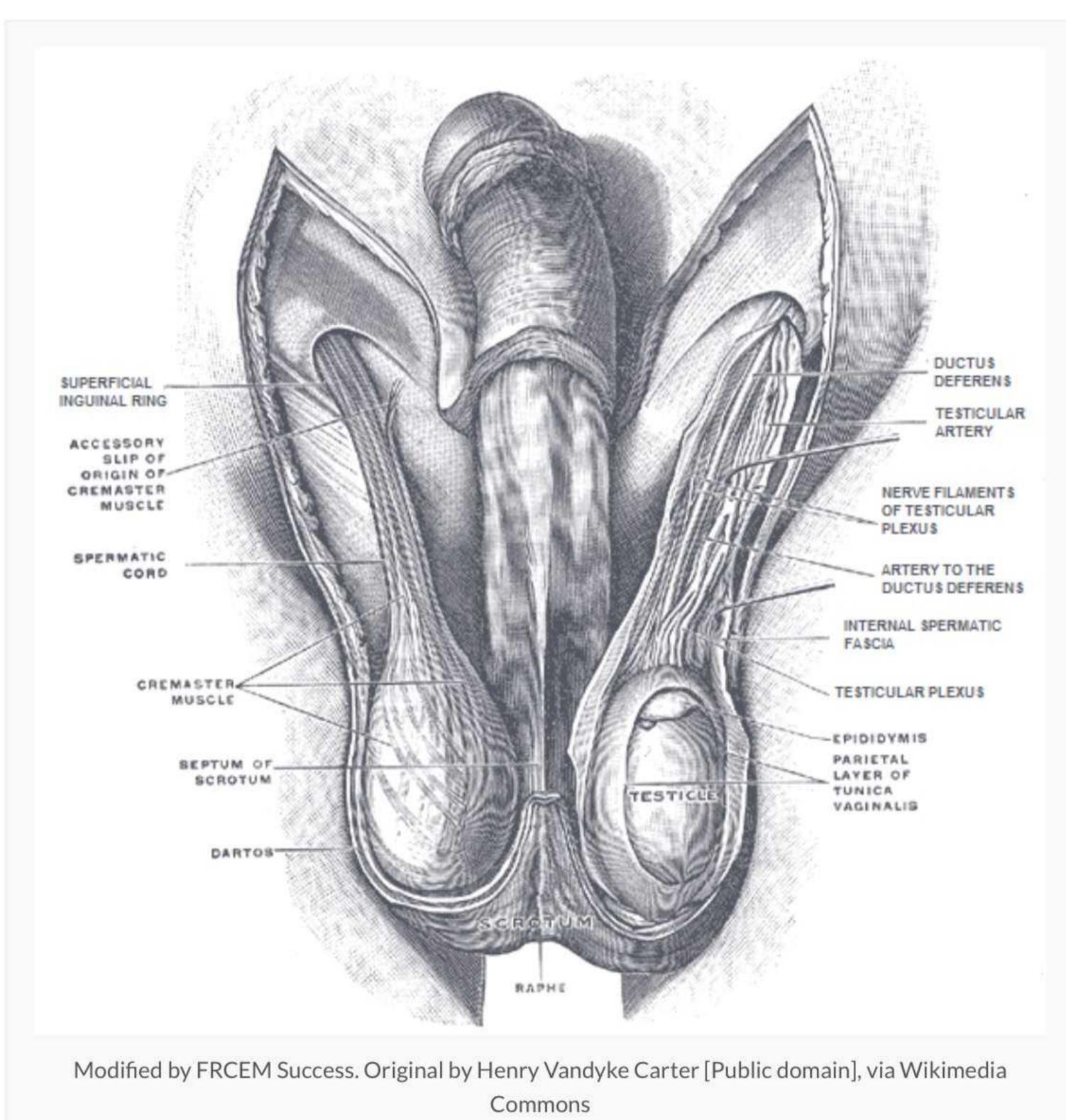
#### Answer

The testes receive their autonomic nerve supply from the testicular plexus. Visceral afferent fibres usually follow the sympathetic fibres to spinal cord levels T10 - L1; pain is thus referred to the periumbilical region, suprapubic region and groin.

#### Notes

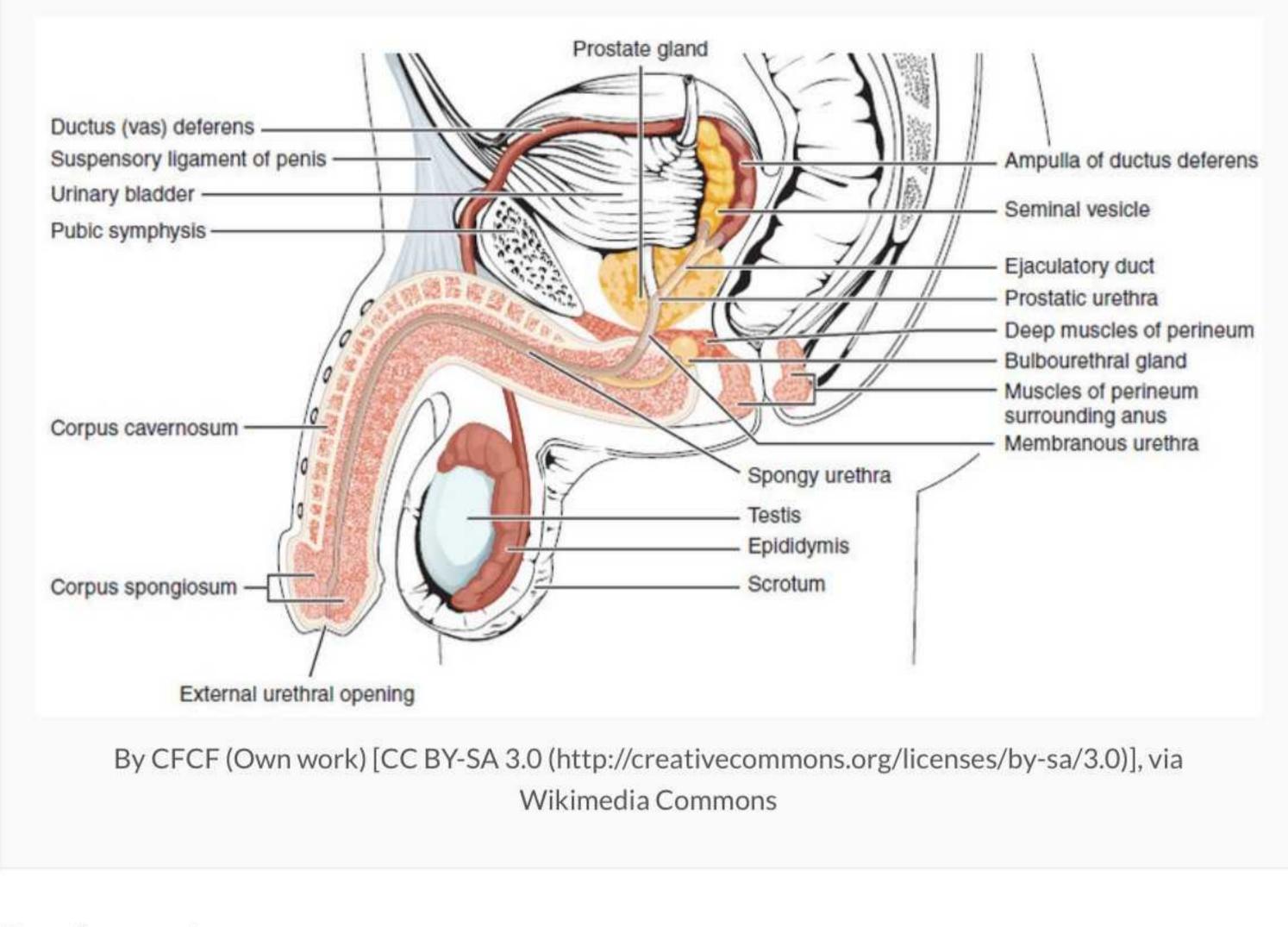
The testis and epididymis are suspended in the scrotum by the spermatic cord. The inferior pole of the testis is attached to the scrotal wall by the scrotal ligament, which is the remnant of the gubernaculum testis.

Each testis is composed of seminiferous tubules (which produce spermatozoa) and interstitial tissue (which secretes testosterone) surrounded by a thick connective tissue capsule, the tunica albuginea. The spermatozoa collects in the epididymis, the tail of which is continuous with the ductus deferens, which transports the spermatozoa to the ejaculatory ducts in the pelvic cavity.



## Ductus deferens

The ductus deferens ascends in the scrotum as part of the spermatic cord and passes through the inguinal canal in the anterior abdominal wall. After exiting the inguinal canal through the deep inguinal ring, it enters the pelvic cavity and descends medially on the pelvic wall, deep to the peritoneum, and crosses the ureter posterior to the bladder. It continues inferomedially along the base of the bladder, anterior to the rectum, almost to the midline where it is joined by the duct of the seminal vesicle to form the ejaculatory duct. The ejaculatory duct penetrates through the prostate gland to connect with the prostatic urethra.



## **Development**

The testes develop high on the posterior abdominal wall and then descend, normally before birth, through the inguinal canal in the anterior abdominal wall and into the scrotum of the perineum. During the descent, the testes carry their vessels, lymphatics, nerves and ductus deferens with them. The spermatic cord is the tube-shaped connection between the pouch in the scrotum and the abdominal wall.

The sides and anterior aspect of the testis are covered by the serous tunica vaginalis, derived from the embryonic processus vaginalis which is originally connected to the abdominal cavity. Normally after testicular descent, the connection closes, leaving a fibrous remnant. Failure of closure can result in the development of an indirect inguinal hernia.

## Blood supply

The testes receive their arterial supply from the testicular artery, direct branch of the abdominal aorta, which travels in the spermatic cord.

## **Lymphatics**

The lymph drainage of the testes is to the lumbar (para-aortic) nodes in the abdomen, in contrast to that of the scrotum which drains to the superficial inguinal nodes.

## Innervation

The testes receive their autonomic nerve supply from the testicular plexus. Visceral afferent fibres usually follow the sympathetic fibres to spinal cord levels T10 - L1; pain is thus referred to the

The scrotum is innervated by nerves derived primarily from spinal roots L1 and S2 – S3:

- anterolaterally by the genital branch of the genitofemoral nerve (L1 L2) anteriorly by scrotal branches of the ilioinguinal nerve (L1)
- posteriorly by scrotal branches of the perineal nerve of the pudendal nerve (S3)
- inferiorly by perineal branches of the posterior femoral cutaneous nerve (S2)

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periumbilical region, suprapubic region and groin.

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# Anatomy: Posterior Abdomen and Pelvis

Question 14 of 119

The abdominal aorta bifurcates into the right and left common iliac arteries at which of the following vertebral levels:

- L3
- L4
- е L5

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See Answer

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# Anatomy: Posterior Abdomen and Pelvis



Question 14 of 119

The abdominal aorta bifurcates into the right and left common iliac arteries at which of the following vertebral levels:

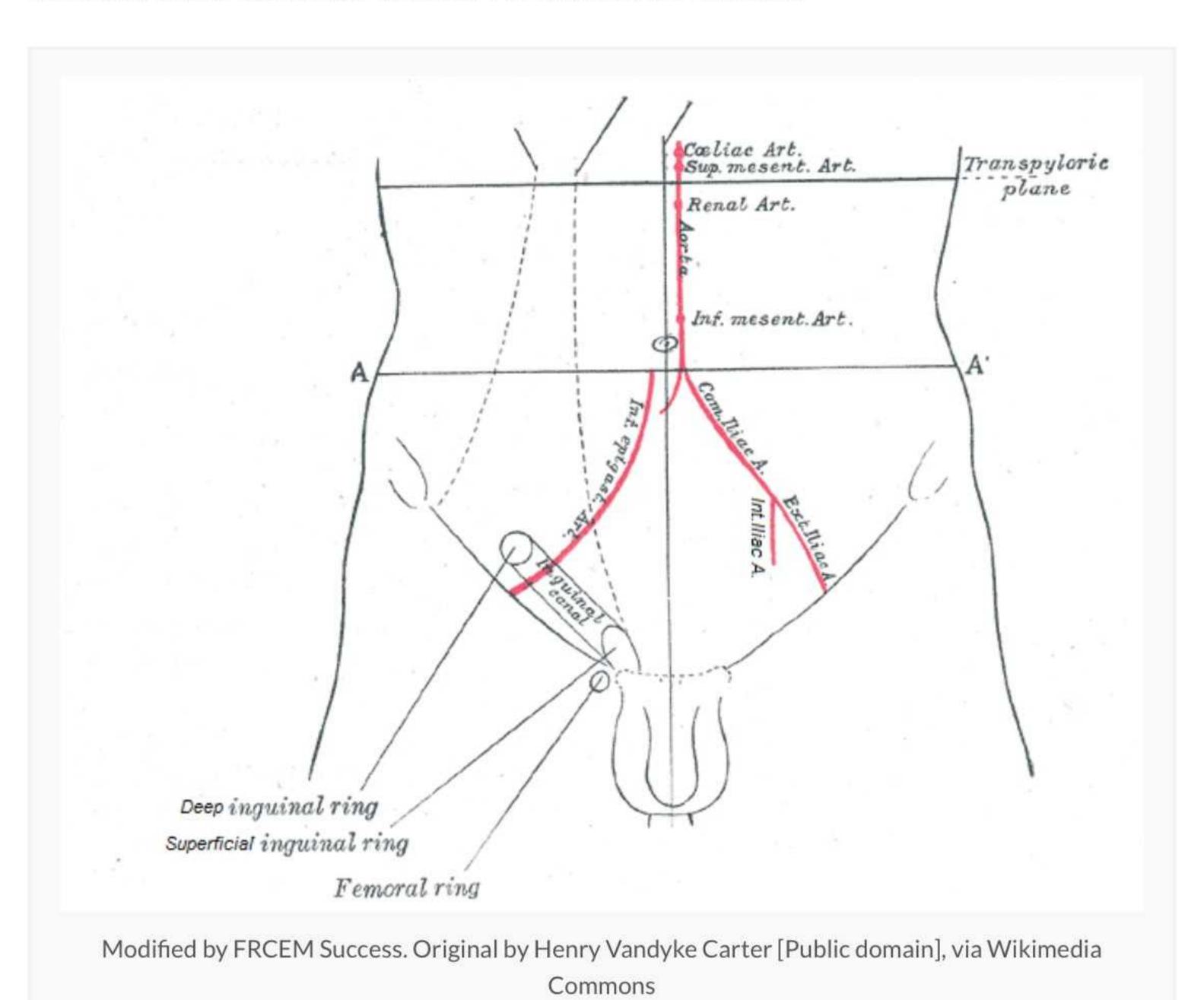
- a) L1 💢
- **b)** L2
- c) L3
- e) L5

#### Answer

The abdominal aorta bifurcates into the right and left common iliac artery at the level of vertebra L4. This bifurcation can be visualised on the anterior abdominal wall as a point approximately 2.5 cm below the umbilicus.

#### Notes

The abdominal aorta begins at the aortic hiatus of the diaphragm, anterior to the lower border of vertebra T12. It descends through the abdomen, anterior to the vertebral bodies, and by the time it ends at the level of vertebra L4 it is slightly to the left of the midline. The main terminal branches of the abdominal aorta are the two common iliac arteries. This bifurcation can be visualised on the anterior abdominal wall as a point approximately 2.5 cm below the umbilicus.



The abdominal aorta gives rise to:

- three anterior unpaired visceral branches
  - the coeliac trunk supplying the abdominal foregut (T12/L1 vertebral level)
  - the superior mesenteric artery supplying the abdominal midgut (L1 vertebral level)
  - the inferior mesenteric artery supplying the abdominal hindgut (L3 vertebral level)
- three lateral paired visceral branches
  - the middle suprarenal arteries
  - the renal arteries (L1/L2 vertebral level)
  - the gonadal arteries
- posterior parietal branches
  - the inferior phrenic arteries (paired)
  - the lumbar arteries (paired)
  - the median sacral artery (single)
- two terminal branches
  - left common iliac artery
  - right common iliac artery

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# Anatomy: Posterior Abdomen and Pelvis

Question 15 of 119



- Pubic tubercle
- Greater trochanter of the femur
- Lesser trochanter of the femur
- Iliac crest
- Anterior superior iliac spine

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See Answer



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# Anatomy: Posterior Abdomen and Pelvis

Question 15 of 119



- a) Pubic tubercle b) Greater trochanter of the femur
- c) Lesser trochanter of the femur
- d) Iliac crest
- e) Anterior superior iliac spine

#### Answer

The psoas major originates from the lateral bodies of, the transverse processes of and the intervertebral discs between the T12 and L1 - L5 vertebrae, essentially covering the anterolateral surface of the bodies of the lumbar vertebrae and filling in the spaces between the vertebral bodies and the transverse processes. It passes inferiorly along the pelvic brim and continues into the anterior thigh to attach to the lesser trochanter of the femur.

## Notes

The most important muscles of the posterior abdominal wall are the psoas major, the iliacus and the quadratus lumborum which each possess a strong fascial covering. Associated with the psoas major muscle is the psoas minor muscle, which is sometimes absent.

-		-	
Muscle	Extent	Action	Innervation
Psoas major (green)	Originates from vertebrae T12 – L5, covers anterolateral bodies of lumbar vertebrae and fills in spaces between vertebral bodies and transverse processes, passes inferiorly along pelvic brim and attaches distally to lesser trochanter of femur	Flexes thigh at hip joint when trunk is stabilised, flexes trunk against gravity when body is supine	Anterior rami L1 – L3
Quadratus lumborum (blue)	Fills space between rib 12 and iliac crest on both sides of vertebral column, overlapped medially by psoas major muscle, lies medial to transversus abdominis muscle	Depresses and stabilises twelfth rib, contributes to lateral bending of trunk	Anterior rami of T12 and L1 - L4
Iliacus (red)	Fills iliac fossa on each side before passing inferiorly to join with psoas major muscle and attach distally to lesser trochanter of femur	Flexes thigh at hip joint when trunk is stabilised, flexes trunk against gravity when body is supine	Femoral nerve (L2 – L4)

#### Psoas major

The psoas major originates from the lateral bodies of, the transverse processes of and the intervertebral discs between the T12 and L1 - L5 vertebrae, essentially covering the anterolateral surface of the bodies of the lumbar vertebrae and filling in the spaces between the vertebral bodies and the transverse processes. It passes inferiorly along the pelvic brim and continues into the anterior thigh to attach to the lesser trochanter of the femur.

The psoas major flexes the thigh at the hip joint when the trunk is stabilised and flexes the trunk against gravity when the body is supine.

It is innervated by the anterior rami of nerves L1 – L3.

The lumbar plexus forms within the psoas major muscle, anterior to its attachment to the transverse process of the lumbar vertebrae.

## Quadratus lumborum

The quadratus lumborum muscles essentially fill the space between rib 12 and the iliac crest on both sides of the vertebral column. They are overlapped medially by the psoas major muscles and along their lateral borders are the transversus abdominis muscles.

The quadratus lumborum muscles depress and stabilise the twelfth ribs and contribute to lateral bending of the trunk. Acting together, the muscles may extend the lumbar part of the vertebral column.

They are innervated by the anterior rami of T12 and L1 – L4.

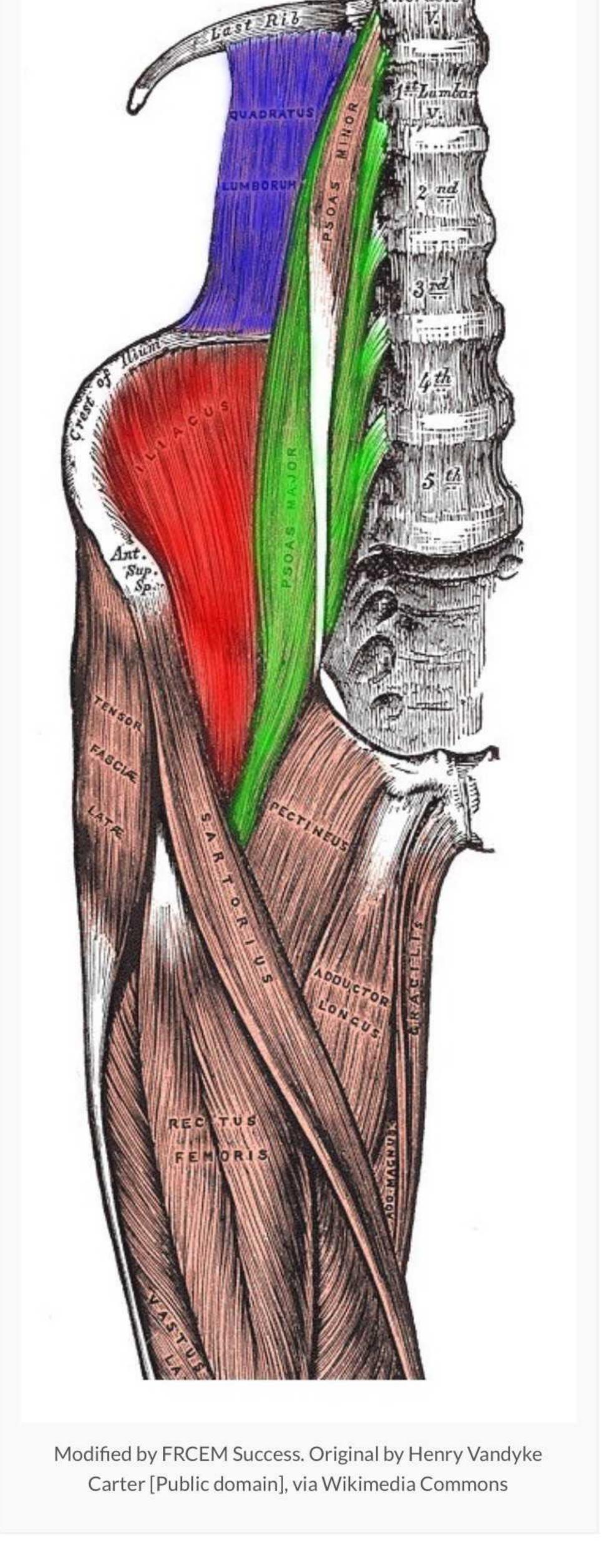
## <u>lliacus</u>

The iliacus muscle fills the iliac fossa on each side, before passing inferiorly to join with the psoas major muscle (forming the iliopsoas muscle) and attach to the lesser trochanter of the femur.

trunk against gravity when the body is supine.

Like the psoas major, the iliacus flexes the thigh at the hip joint when the trunk is stabilised and flexes the

It is innervated by branches of the femoral nerve.



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# Anatomy: Posterior Abdomen and Pelvis

Question 16 of 119



- Posterolateral gluteal region
- Medial thigh
- Lateral thigh
- Posteromedial gluteal region
- Upper anterior thigh

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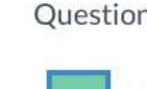
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# Anatomy: Posterior Abdomen and Pelvis

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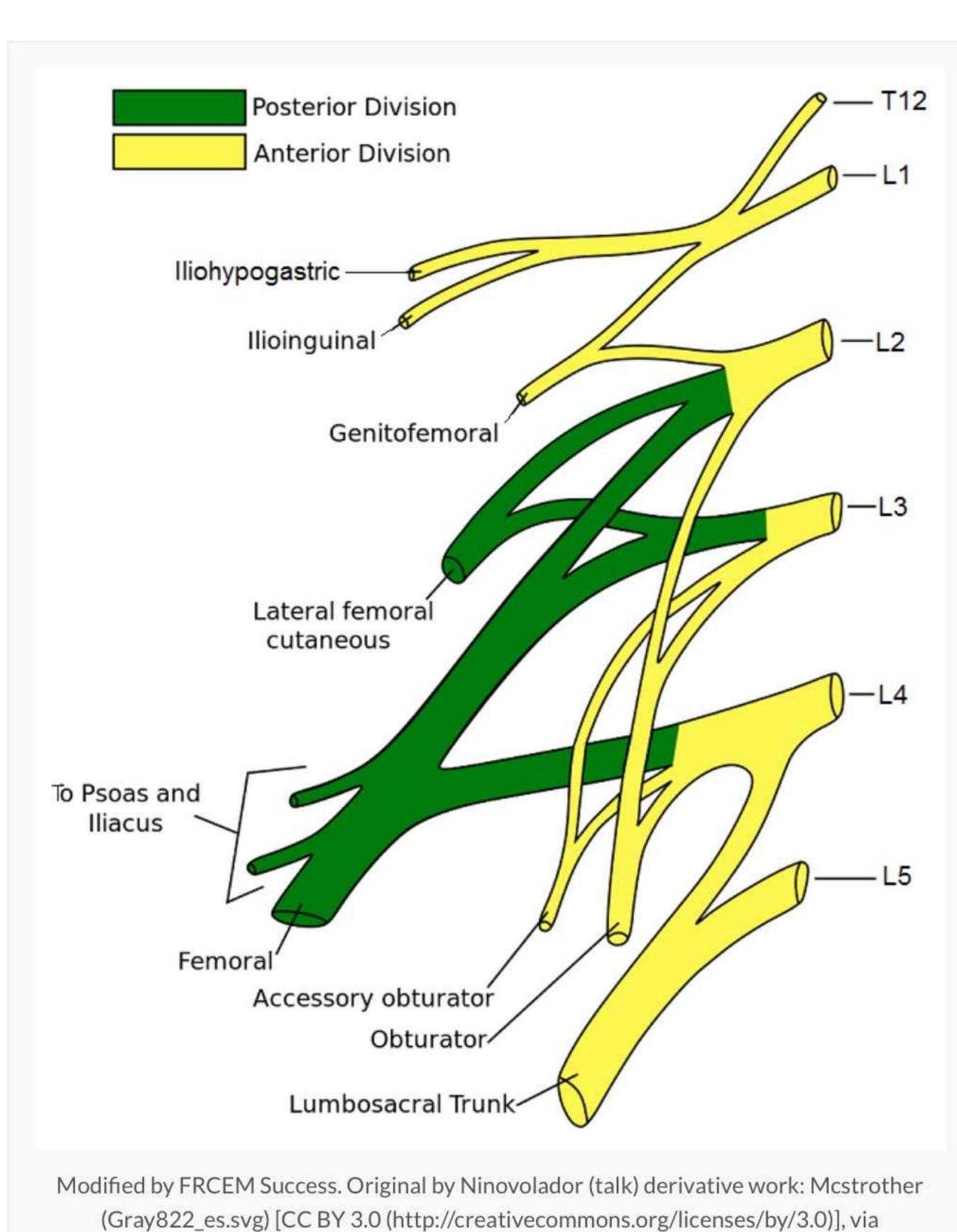
- a) Posterolateral gluteal region
- **b)** Medial thigh
- c) Lateral thigh
- d) Posteromedial gluteal region e) Upper anterior thigh

## Answer

The iliohypogastric nerve is formed from the anterior rami of L1. It innervates the internal oblique and the transversus abdominis muscles and supplies posterolateral gluteal skin and skin over the pubic region.

## Notes

The lumbar plexus is formed by the anterior rami of nerves L1 – L3 and most of the anterior ramus of L4. It also receives a contribution from the T12 (subcostal) nerve. The lumbar plexus forms within the substance of the psoas major muscle, anterior to its attachment to the transverse processes of the lumbar vertebrae.



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## Lumbar nerves

Nerve	Spinal segment	Motor function	Sensory function
Iliohypogastric nerve	L1	Internal oblique and transversus abdominis	Posterolateral gluteal skin and skin in pubic region
Ilioinguinal nerve	L1	Internal oblique and transversus abdominis	Skin in upper medial thigh, and either skin over root of penis and anterior scrotum or mons pubis and labium majus
Genitofemoral	L1, L2	Male cremasteric muscle	Skin of anterior scrotum or skin of mons pubis and labium majus (genital branch), skin of upper anterior thigh (genitofemoral nerve)
Lateral cutaneous nerve of thigh	L2, L3	N/A	Skin on lateral thigh to knee
Obturator	L2 – L4	Obturator externus, gracilis and adductor muscles	Skin on medial aspect of thigh
Femoral nerve	L2 – L4	Iliacus, pectineus, sartorius and quadriceps femoris	Skin on anterior thigh and medial leg

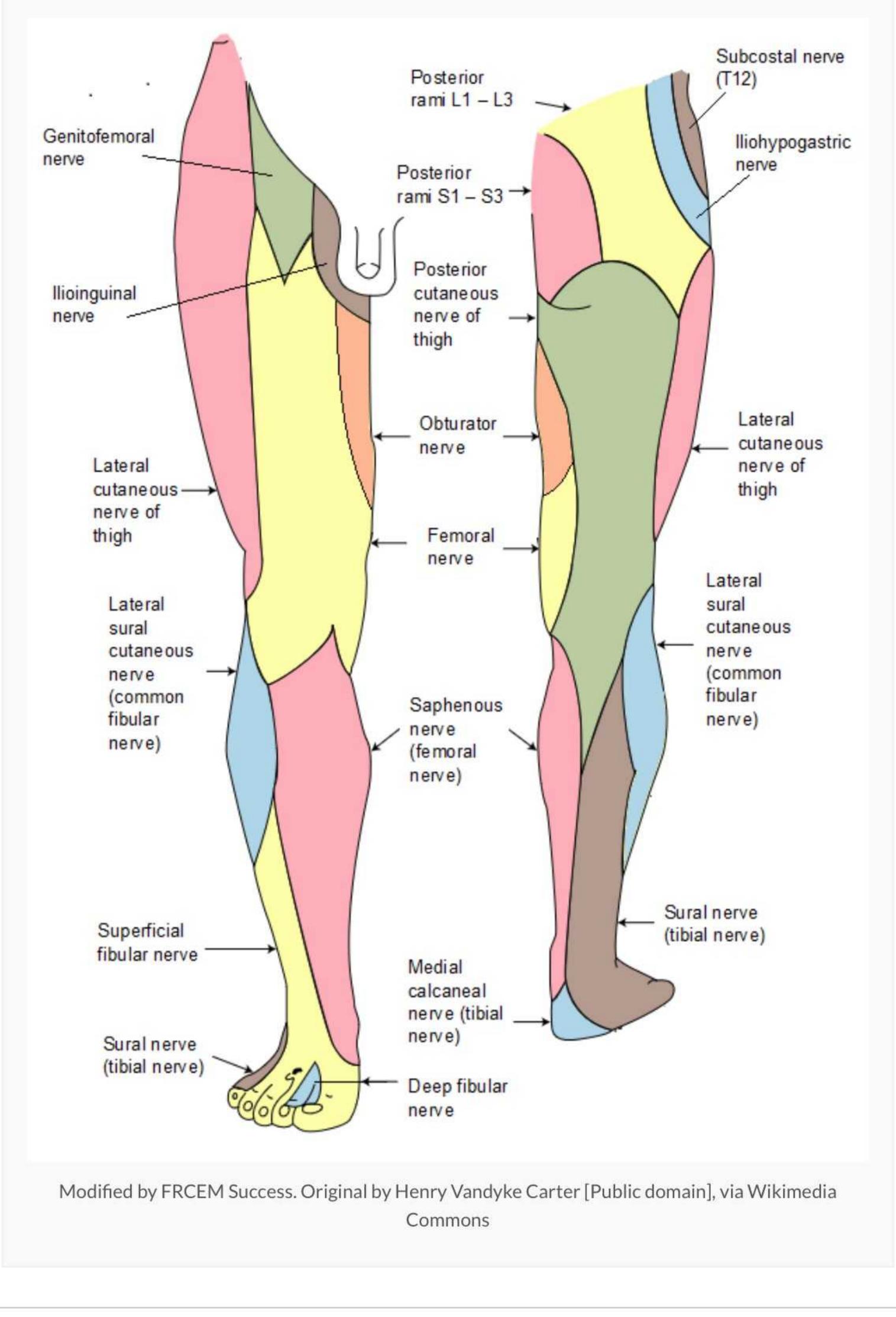
oblique and the transversus abdominis and supplies posterolateral gluteal skin and skin over the pubic region. • The ilioinguinal nerve is formed from the anterior rami of L1. It innervates the internal oblique

• The iliohypogastric nerve is formed from the anterior rami of L1. It innervates the internal

- and transversus abdominis and supplies skin over the upper medial thigh and the external genitalia. • The genitofemoral nerve is formed from the anterior rami of L1 and L2. Its genital branch
- innervates the male cremaster muscle and supplies skin over the external genitalia and its femoral branch supplies skin of the upper anterior thigh.
- The lateral cutaneous nerve of the thigh (lateral femoral cutaneous nerve) is formed from the anterior rami of L2 and L3. It supplies skin on the anterolateral thigh to the knee.
- externus and the muscles in the medial compartment of the thigh and supplies skin on the medial aspect of the thigh. • The femoral nerve is formed from the anterior rami of L2 to L4. It innervates the iliacus,

• The obturator nerve is formed from the anterior rami of L2 to L4. It innervates the obturator

pectineus, sartorius and muscles in the anterior compartment of the thigh and supplies skin on the anterior thigh and medial surface of leg.



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# Anatomy: Posterior Abdomen and Pelvis Question 17 of 119

The kidneys are related posteriorly to all of the following structures **EXCEPT** for the:

- Diaphragm
- b Psoas major muscle
- Quadratus lumborum muscle
- Transversus abdominis muscle
- Iliacus muscle

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See Answer

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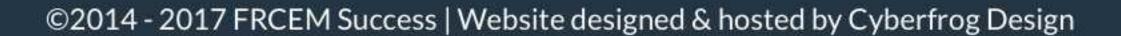




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# Anatomy: Posterior Abdomen and Pelvis

Question 17 of 119

The kidneys are related posteriorly to all of the following structures EXCEPT for the:

- a) Diaphragm 💥
- b) Psoas major muscle c) Quadratus lumborum muscle
- d) Transversus abdominis muscle
- e) Iliacus muscle

## Answer

Posteriorly both kidneys are related superiorly to the diaphragm and ribs and inferiorly (moving from medial to lateral) the psoas major, quadratus lumborum and transversus abdominis muscles. The pleural sacs and the costodiaphragmatic recesses also extend posterior to the kidneys.

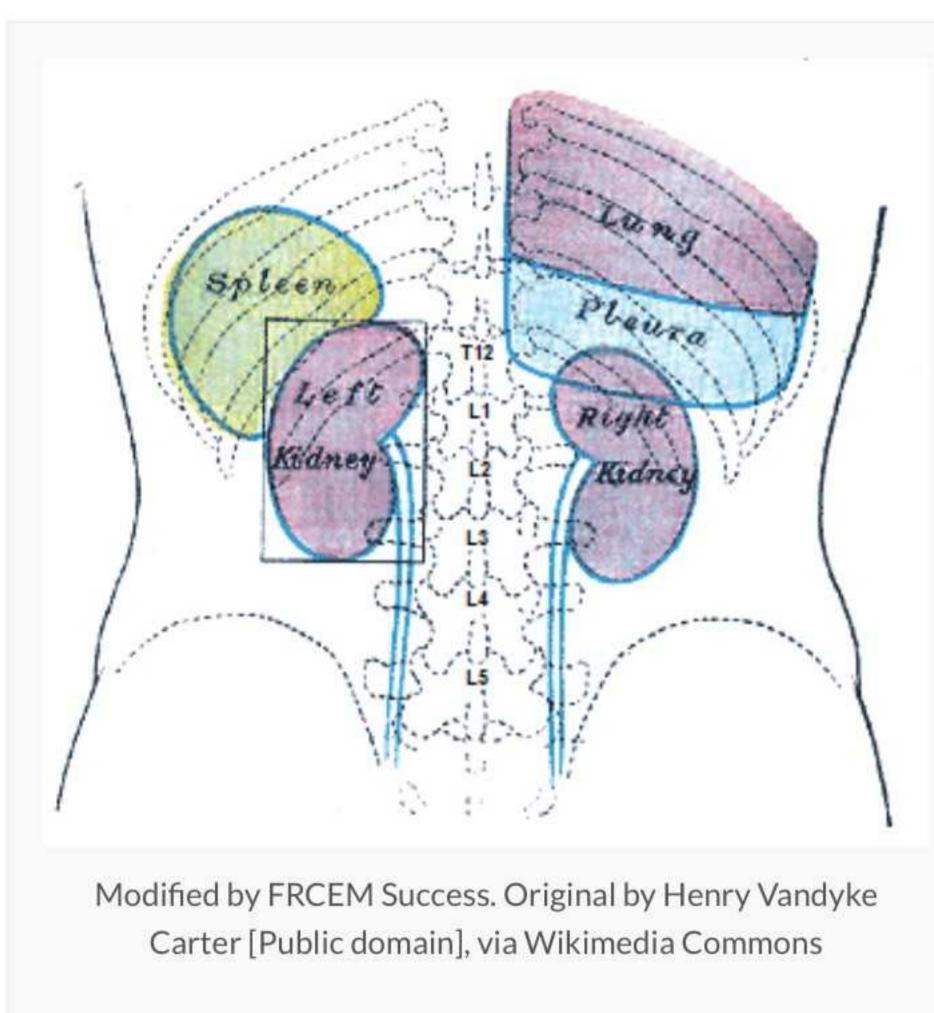
## Notes

The kidneys are retroperitoneal organs. They lie in the extraperitoneal connective tissue immediately lateral to the vertebral column in the upper left and right abdominal quadrants.

Viscera	Kidney
Surface marking	Extend between vertebrae T12 – L3, left kidney slightly higher than right, renal hila at vertebral level L1
Anterior relations	RIGHT: right adrenal gland, liver, second part of duodenum, right colic flexure, segment of small intestine. LEFT: left adrenal gland, spleen, pancreas, stomach, left colic flexure and descending colon, duodenojejunal flexure and coils of small intestine
Posterior relations	Diaphragm, psoas major, quadratus lumborum and transversus abdominis muscles
Structure	Each kidney covered by fibrous capsule and surrounded by renal fascia, kidney itself made up of outer renal cortex and inner renal medulla, renal pelvis continuous with ureters
Blood	Renal artery (branch of abdominal aorta arising at vertebral level L1/L2 posterior to the pancreas), divides into segmental arteries to supply renal parenchyma
Lymphatics	Lumbar (para-aortic) lymph nodes
Innervation	Via renal plexus, parasympathetic fibres from vagus nerve and sympathetic fibres from thoracic splanchnic nerves

## Surface markings

The position of the kidneys varies with respiration and the position of the body. In the supine position, the kidneys extend from approximately vertebra T12 superiorly to vertebra L3 inferiorly. The left kidney is a little higher than the right, reaching as high as rib 11, compared to rib 12 for the right kidney (because of its relationship with the liver). The hila of the kidneys and the beginning of the ureters are at the level of the L1 vertebra.



## Relations

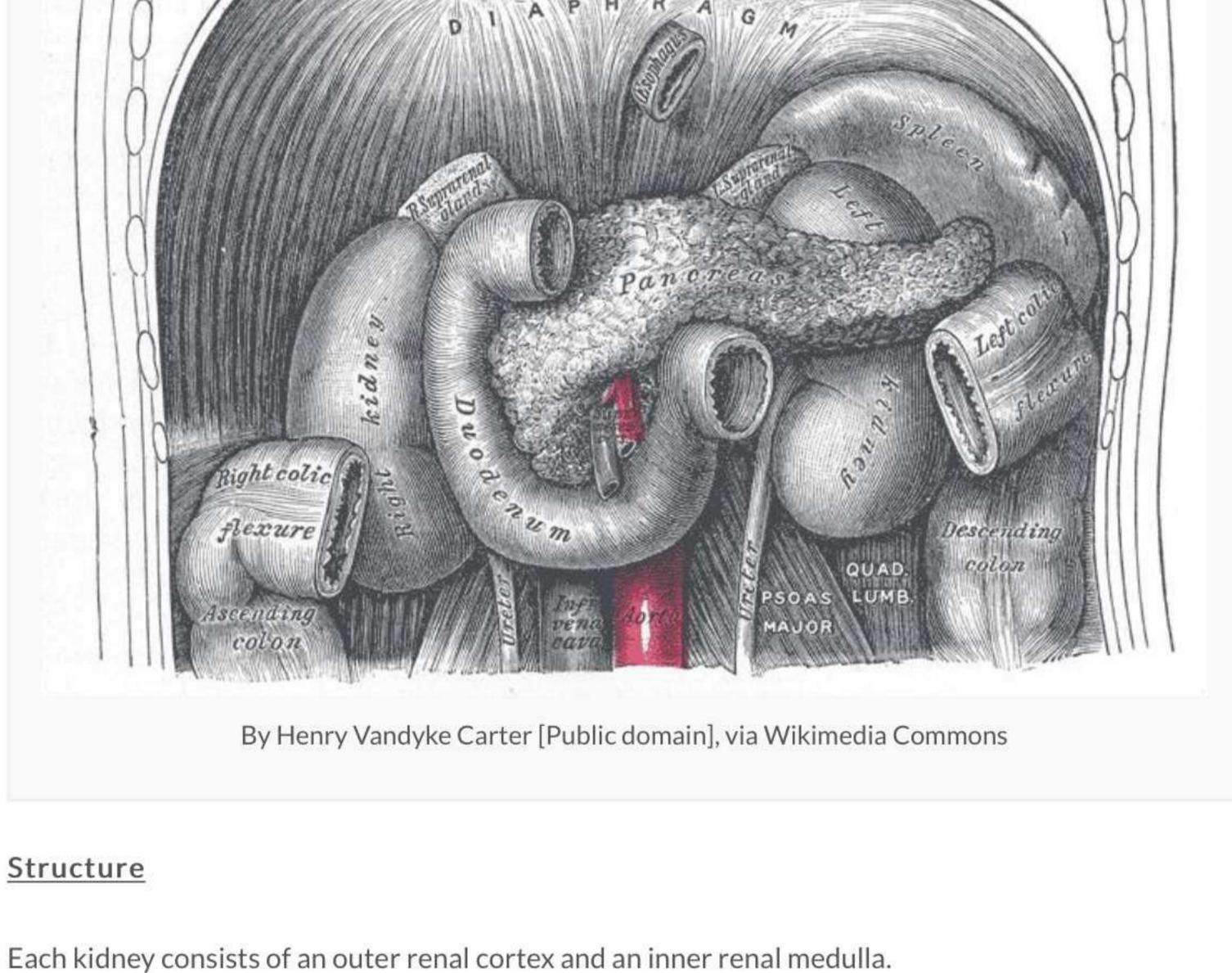
The anterior surface of the right kidney is related to the (superiorly to inferiorly):

- right adrenal gland medially liver
- second part of the duodenum medially, right colic flexure laterally
- a segment of small intestine medially.
- The anterior surface of the left kidney is related to the (superiorly to inferiorly):

left adrenal gland medially

- spleen laterally
- pancreas stomach (the kidney forms part of the stomach bed)
- left colic flexure and descending colon laterally duodenojejunal flexure and coils of small intestine

medial to lateral) the psoas major, quadratus lumborum and transversus abdominis muscles. The pleural sacs and the costodiaphragmatic recesses also extend posterior to the kidneys.



Posteriorly both kidneys are related superiorly to the diaphragm and ribs and inferiorly (moving from

Extensions of the renal cortex (the renal columns) project into the inner aspect of the kidney, dividing the

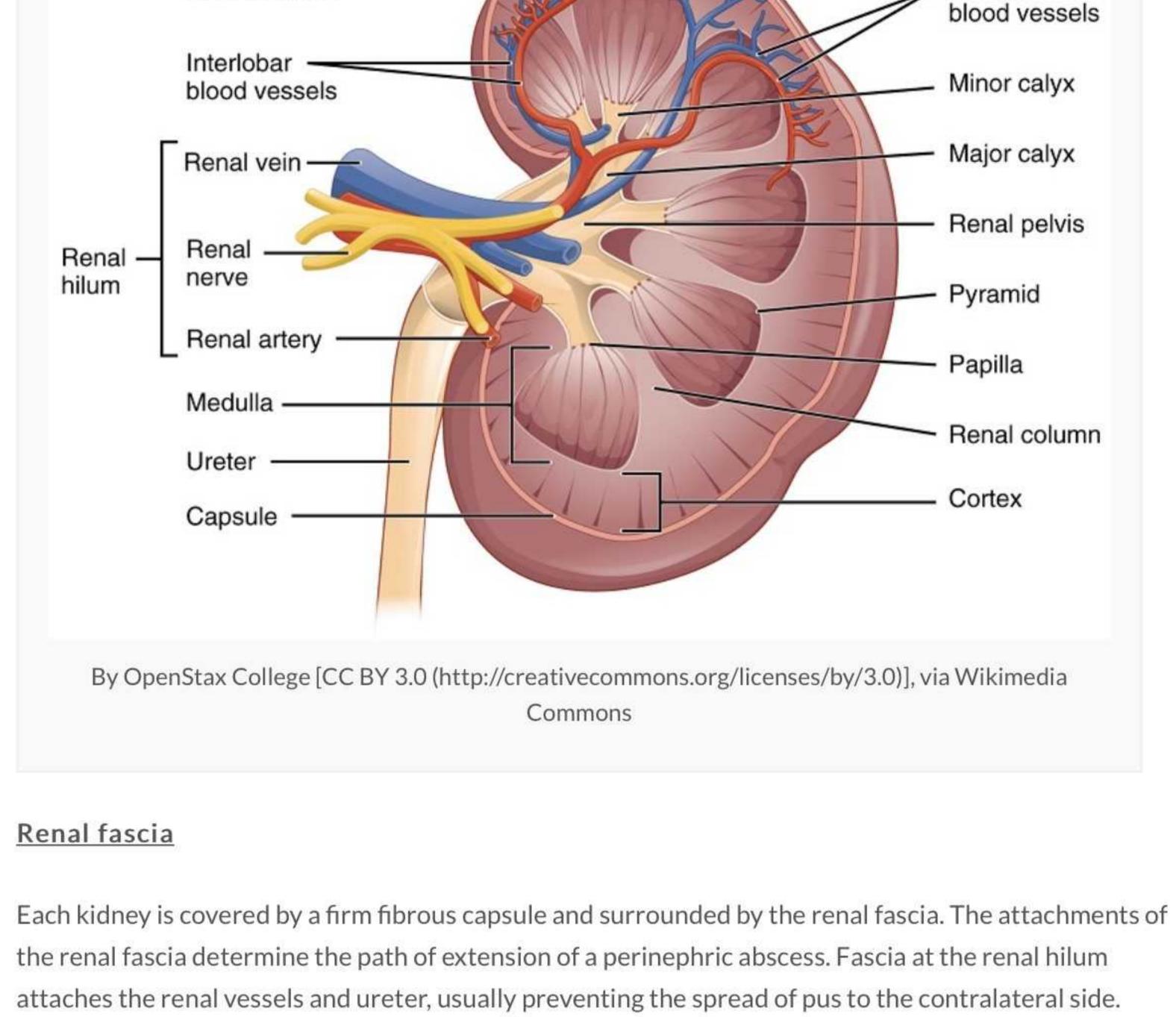
Cortical -

blood vessels

renal medulla into the renal pyramids. The base of the renal pyramids are directed outwards towards the renal cortex, while the apex of each renal pyramid projects inwards towards the renal sinus, a cavity which is occupied by the renal calyces, blood vessels, nerves and fat.

The apical projection of the renal pyramid is surrounded by a minor calyx into which the collecting ducts drain. Several minor calyces unite to form a major calyx, and two or three major calyces unite to form the renal pelvis, which is continuous with the ureter.

Arcuate



# However pus from an abscess may force its way into the pelvis between the loosely attached anterior

and posterior layers of the renal fascia. Blood supply The renal artery arises from the abdominal aorta just inferior to the origin of the superior mesenteric

artery just between vertebrae L1 and L2 and posterior to the pancreas.

## Each renal artery enters the kidney via the renal hilum, dividing into segmental branches. These branches undergo further divisions to supply the renal parenchyma.

Lymphatic drainage

The lymphatic drainage is to the lumbar (para-aortic) lymph nodes located at the origin of the renal

# arteries.

**Innervation** The kidneys receive autonomic nerve fibres via the renal plexus which contains parasympathetic fibres

from the vagus nerve and sympathetic fibres from the thoracic splanchnic nerves.

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1 Answered

2 Answered





# Anatomy: Posterior Abdomen and Pelvis

Question 18 of 119



- Anterior lobe of prostate
- Fibromuscular zone of prostate
- Lateral lobe of prostate
- Posterior lobe of prostate
- Transitional zone of prostate

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See Answer

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1 Answered

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MENU

# Anatomy: Posterior Abdomen and Pelvis



Question 18 of 119

A 75 year old man presents to ED in acute urinary retention. On examination you note the prostate feels hard and craggy. You suspect prostate cancer. Which structure is most likely affected:

- a) Anterior lobe of prostate
- b) Fibromuscular zone of prostate
- c) Lateral lobe of prostate
- d) Posterior lobe of prostate
- e) Transitional zone of prostate

#### Answer

Anatomically the prostate has four main lobes: two lateral lobes, a posterior lobe and a median lobe that directly surrounds the urethra. Benign prostatic hypertrophy most commonly affects the median lobe. The posterior lobe is the area most prone to carcinomatous change, and the area palpated on PR examination.

#### Notes

The prostate is an unpaired accessory structure of the male reproduction system that surrounds the prostatic urethra in the pelvic cavity. It typically weighs between 20 - 40 g with an average size of 4 x 3 x 2 cm (its width being the greatest).

Secretions from the prostate, together with secretions from the seminal vesicle, contribute to the formation of semen during ejaculation. The ejaculatory ducts pass almost vertically in an anteroinferior direction through the posterior aspect of the prostate to open into the prostatic urethra.

#### Relations

The prostate lies immediately inferior to the bladder and the internal urethral sphincter, superior to the external urethral sphincter (with the levator anilying inferolaterally to the gland) and anterior to the rectum. The urethra passes through the prostate.

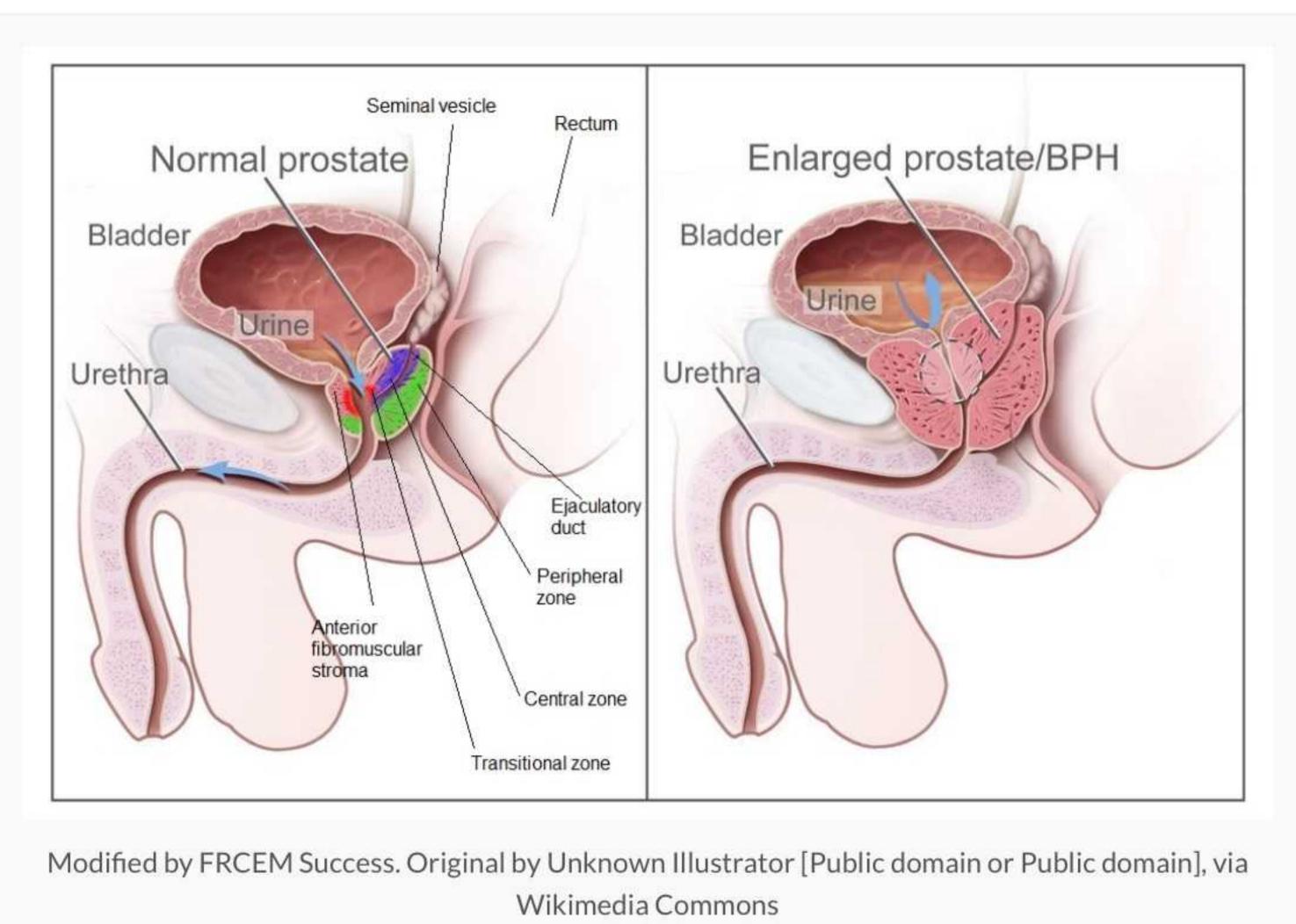
### <u>Structure</u>

Traditionally the prostate gland is divided anatomically into lobules, but more important clinically is specific anatomical zones rather than lobes:

- The transitional zone is the most central part of the gland that surrounds the prostatic urethra and the area most prone to prostatic hyperplasia, resulting in urinary symptoms.
- The central zone encircles the transitional zone and encompasses the ejaculatory ducts posterior to the prostatic urethra.
- The peripheral zone is the outermost region of the prostate and the area most prone to carcinomatous transformation. This is the zone palpated on PR examination.

## Lymphatic drainage

The prostate gland has several lymphatic drainage pathways primarily to the internal iliac nodes with some drainage to external iliac and presacral nodes.



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# Anatomy: Posterior Abdomen and Pelvis

Question 19 of 119



- Posterolateral gluteal region
- b Lateral thigh
- Upper medial thigh
- Upper anterior thigh
- Posteromedial gluteal region

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See Answer

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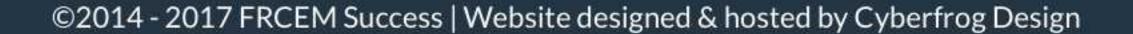
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# Anatomy: Posterior Abdomen and Pelvis

Question 19 of 119

The genitofemoral nerve supplies skin over which of the following regions:

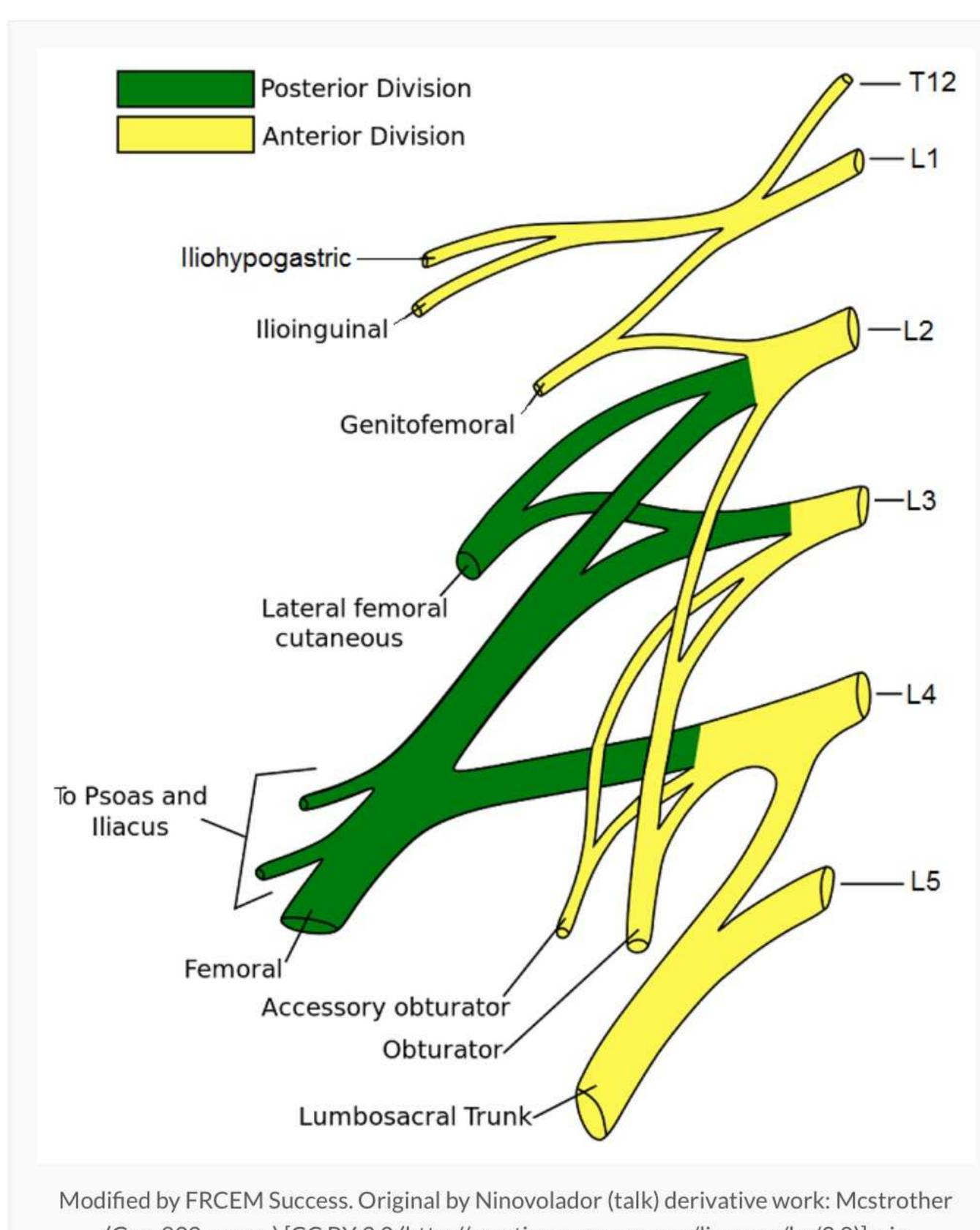
- a) Posterolateral gluteal region
- b) Lateral thigh
- c) Upper medial thigh d) Upper anterior thigh
- e) Posteromedial gluteal region

## Answer

The genitofemoral nerve is formed from the anterior rami of L1 and L2. Its genital branch innervates the male cremaster muscle and supplies skin over the external genitalia and its femoral branch supplies skin of the upper anterior thigh.

## Notes

The lumbar plexus is formed by the anterior rami of nerves L1 – L3 and most of the anterior ramus of L4. It also receives a contribution from the T12 (subcostal) nerve. The lumbar plexus forms within the substance of the psoas major muscle, anterior to its attachment to the transverse processes of the lumbar vertebrae.



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## Lumbar nerves

Nerve	Spinal segment	Motor function	Sensory function
Iliohypogastric nerve	L1	Internal oblique and transversus abdominis	Posterolateral gluteal skin and skin in pubic region
Ilioinguinal nerve	L1	Internal oblique and transversus abdominis	Skin in upper medial thigh, and either skin over root of penis and anterior scrotum or mons pubis and labium majus
Genitofemoral	L1, L2	Male cremasteric muscle	Skin of anterior scrotum or skin of mons pubis and labium majus (genital branch), skin of upper anterior thigh (genitofemoral nerve)
Lateral cutaneous nerve of thigh	L2, L3	N/A	Skin on lateral thigh to knee
Obturator	L2 – L4	Obturator externus, gracilis and adductor muscles	Skin on medial aspect of thigh
Femoral nerve	L2 – L4	Iliacus, pectineus, sartorius and quadriceps femoris	Skin on anterior thigh and medial leg

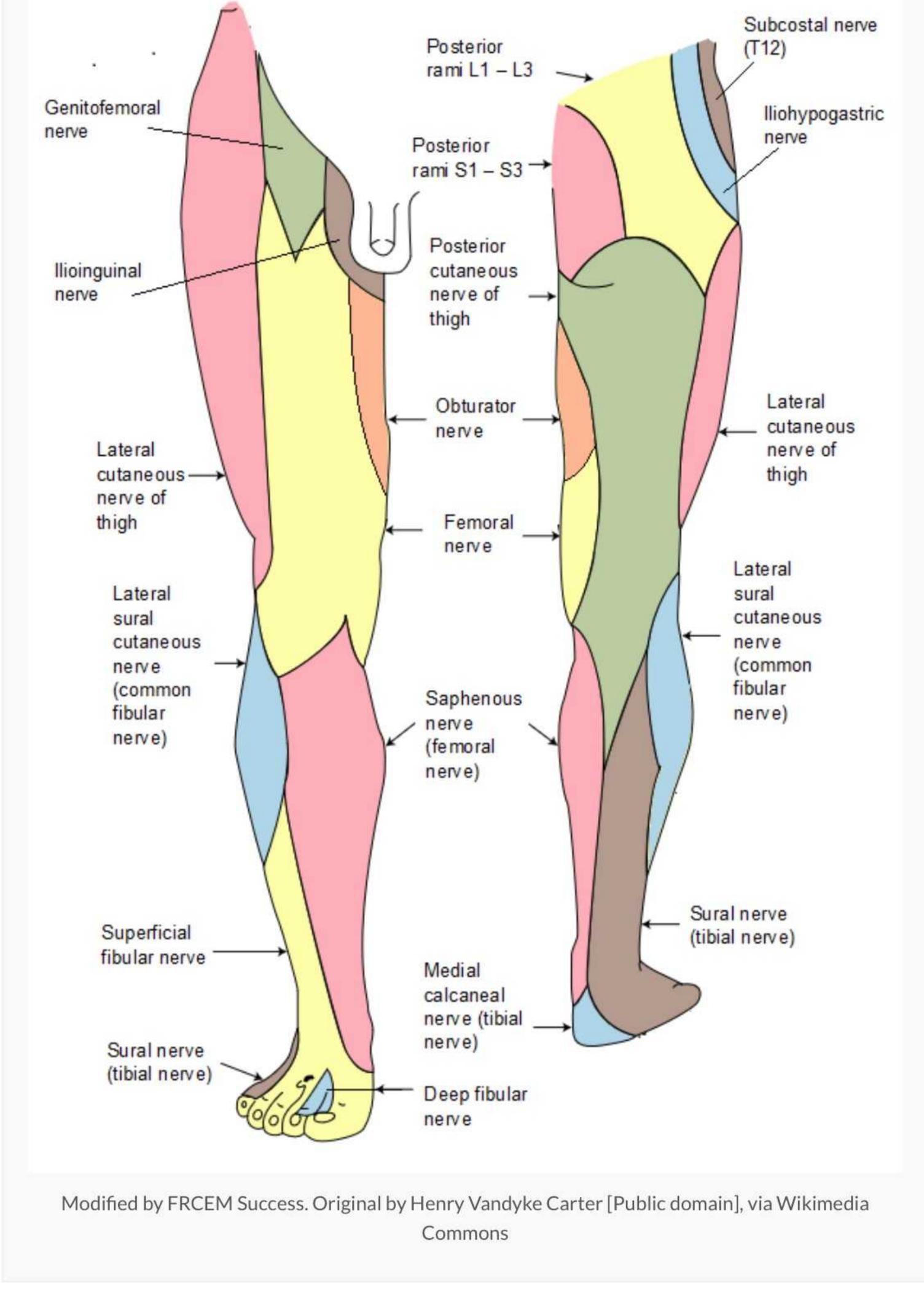
oblique and the transversus abdominis and supplies posterolateral gluteal skin and skin over the pubic region. • The ilioinguinal nerve is formed from the anterior rami of L1. It innervates the internal oblique

• The iliohypogastric nerve is formed from the anterior rami of L1. It innervates the internal

- and transversus abdominis and supplies skin over the upper medial thigh and the external genitalia. • The genitofemoral nerve is formed from the anterior rami of L1 and L2. Its genital branch
- innervates the male cremaster muscle and supplies skin over the external genitalia and its femoral branch supplies skin of the upper anterior thigh. • The lateral cutaneous nerve of the thigh (lateral femoral cutaneous nerve) is formed from the
- anterior rami of L2 and L3. It supplies skin on the anterolateral thigh to the knee. • The obturator nerve is formed from the anterior rami of L2 to L4. It innervates the obturator

the anterior thigh and medial surface of leg.

- externus and the muscles in the medial compartment of the thigh and supplies skin on the medial aspect of the thigh. • The femoral nerve is formed from the anterior rami of L2 to L4. It innervates the iliacus, pectineus, sartorius and muscles in the anterior compartment of the thigh and supplies skin on
- Subcostal nerve Posterior rami L1 - L3 Genitofemoral lliohypogastric nerve nerve



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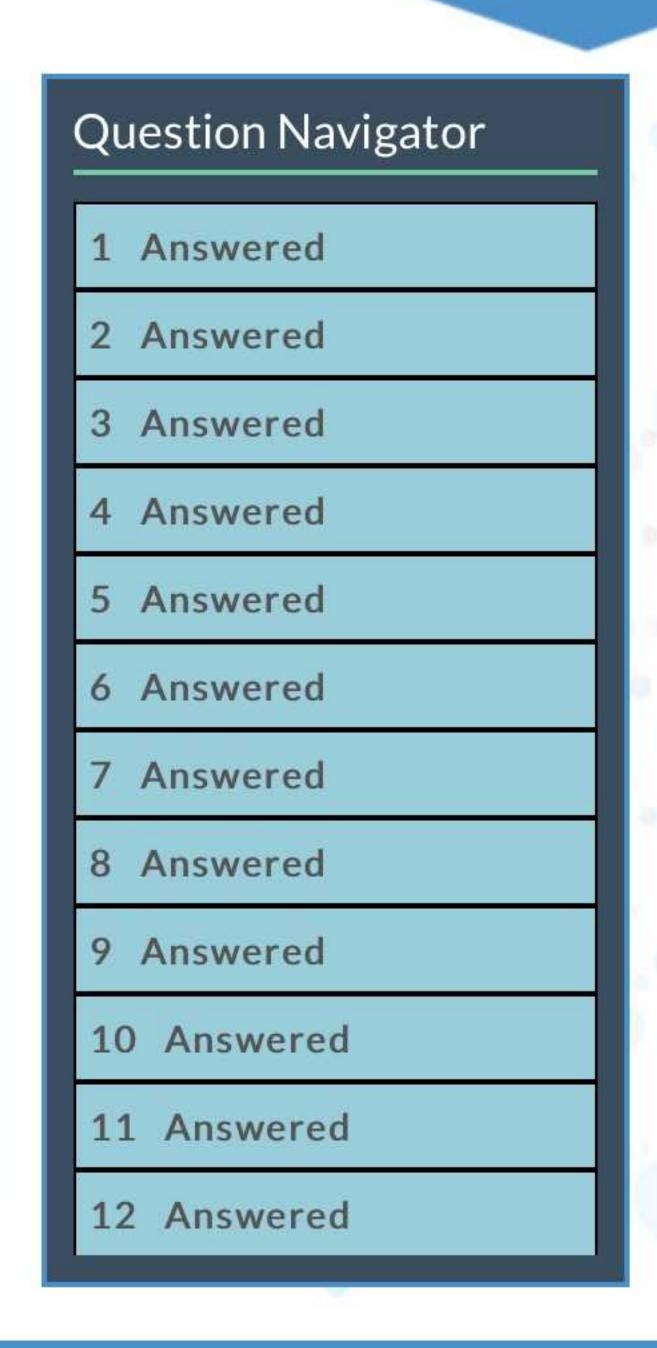




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# Anatomy: Posterior Abdomen and Pelvis Question 20 of 119 The renal pelvis is continuous with which of the following structures: a The minor calyx b The renal pyramid c The major calyx d The renal sinus e The ureter



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# Anatomy: Posterior Abdomen and Pelvis

Question 20 of 119

The renal pelvis is continuous with which of the following structures:



- a) The minor calyx
- b) The renal pyramid
- c) The major calyx d) The renal sinus
- e) The ureter

## Answer

The apical projection of the renal pyramid is surrounded by a minor calyx into which the collecting ducts drain. Several minor calyces unite to form a major calyx, and two or three major calyces unite to form the renal pelvis, which is continuous with the ureter.

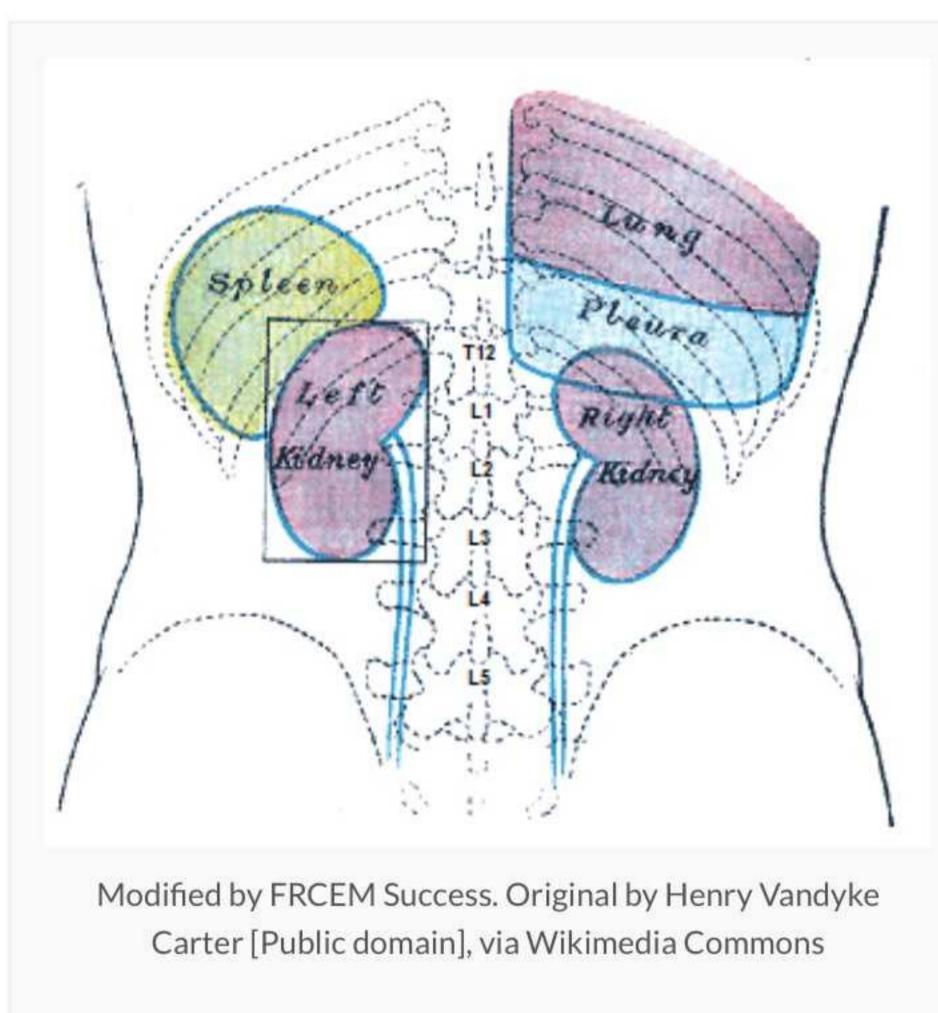
## Notes

The kidneys are retroperitoneal organs. They lie in the extraperitoneal connective tissue immediately lateral to the vertebral column in the upper left and right abdominal quadrants.

Viscera	Kidney	
Surface marking	Extend between vertebrae T12 – L3, left kidney slightly higher than right, renal hila at vertebral level L1	
Anterior relations	RIGHT: right adrenal gland, liver, second part of duodenum, right colic flexure, segment of small intestine. LEFT: left adrenal gland, spleen, pancreas, stomach, left colic flexure and descending colon, duodenojejunal flexure and coils of small intestine	
Posterior relations	Diaphragm, psoas major, quadratus lumborum and transversus abdominis muscles	
Structure	Each kidney covered by fibrous capsule and surrounded by renal fascia, kidney itself made up of outer renal cortex and inner renal medulla, renal pelvis continuous with ureters	
Blood	Renal artery (branch of abdominal aorta arising at vertebral level L1/L2 posterior to the pancreas), divides into segmental arteries to supply renal parenchyma	
Lymphatics	Lumbar (para-aortic) lymph nodes	
Innervation	Via renal plexus, parasympathetic fibres from vagus nerve and sympathetic fibres from thoracic splanchnic nerves	

## Surface markings

The position of the kidneys varies with respiration and the position of the body. In the supine position, the kidneys extend from approximately vertebra T12 superiorly to vertebra L3 inferiorly. The left kidney is a little higher than the right, reaching as high as rib 11, compared to rib 12 for the right kidney (because of its relationship with the liver). The hila of the kidneys and the beginning of the ureters are at the level of the L1 vertebra.



Relations

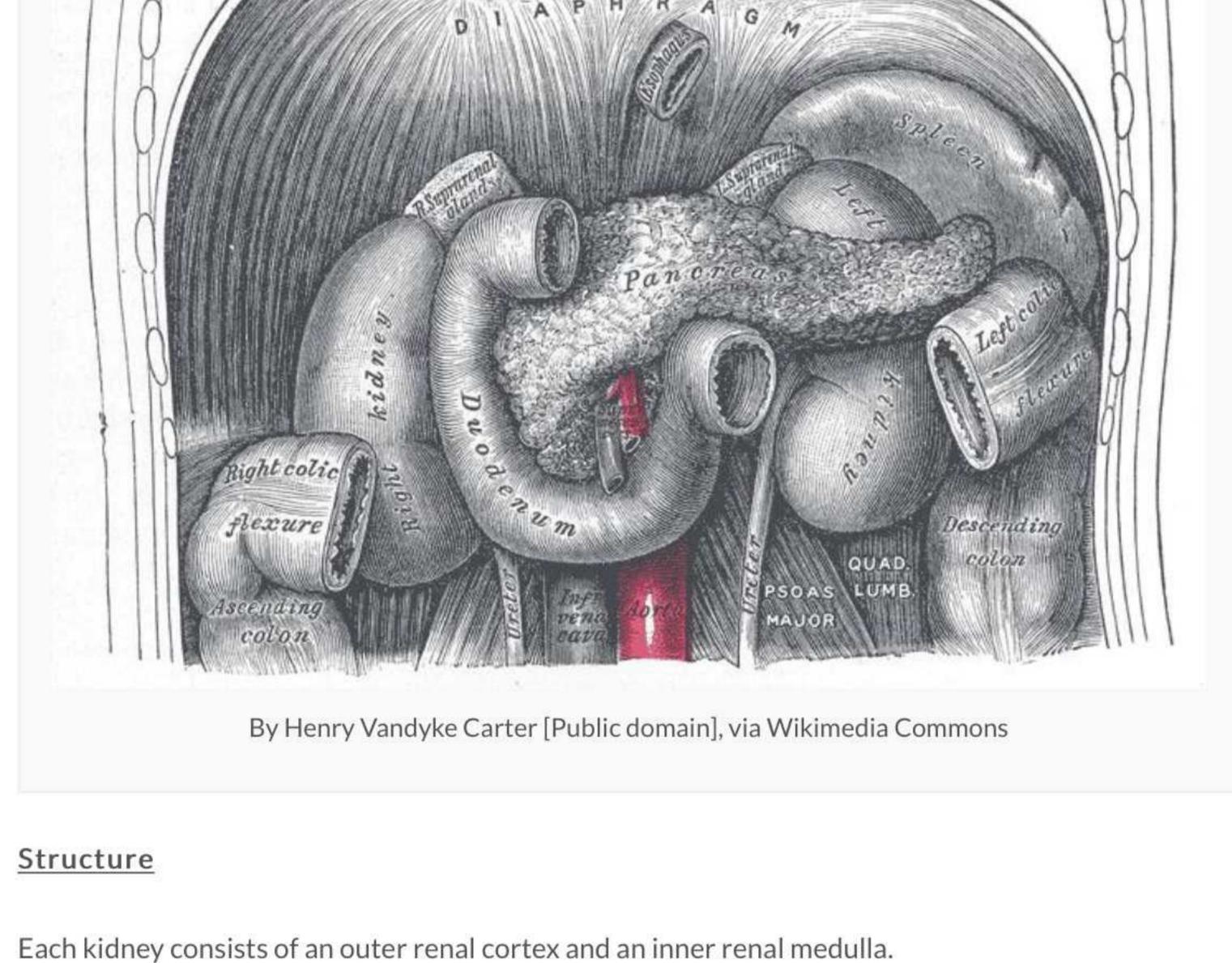
The anterior surface of the right kidney is related to the (superiorly to inferiorly):

- right adrenal gland medially
- liver
- second part of the duodenum medially, right colic flexure laterally
- a segment of small intestine medially.

The anterior surface of the left kidney is related to the (superiorly to inferiorly): left adrenal gland medially

sacs and the costodiaphragmatic recesses also extend posterior to the kidneys.

- spleen laterally
- pancreas stomach (the kidney forms part of the stomach bed)
- left colic flexure and descending colon laterally duodenojejunal flexure and coils of small intestine
- Posteriorly both kidneys are related superiorly to the diaphragm and ribs and inferiorly (moving from medial to lateral) the psoas major, quadratus lumborum and transversus abdominis muscles. The pleural



Extensions of the renal cortex (the renal columns) project into the inner aspect of the kidney, dividing the

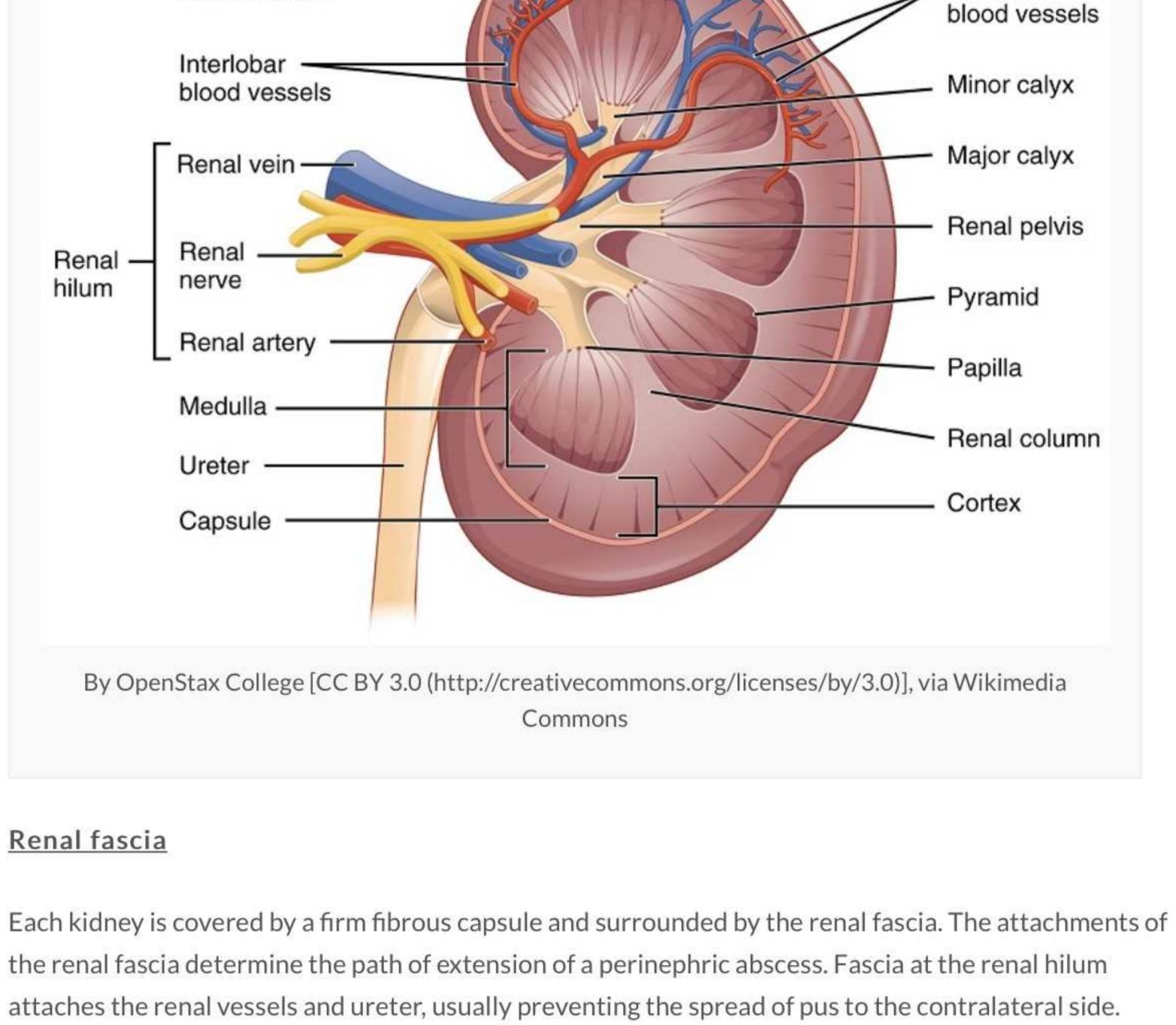
Cortical -

blood vessels

renal medulla into the renal pyramids. The base of the renal pyramids are directed outwards towards the renal cortex, while the apex of each renal pyramid projects inwards towards the renal sinus, a cavity which is occupied by the renal calyces, blood vessels, nerves and fat.

The apical projection of the renal pyramid is surrounded by a minor calyx into which the collecting ducts drain. Several minor calyces unite to form a major calyx, and two or three major calyces unite to form the renal pelvis, which is continuous with the ureter.

Arcuate



## However pus from an abscess may force its way into the pelvis between the loosely attached anterior and posterior layers of the renal fascia.

Blood supply The renal artery arises from the abdominal aorta just inferior to the origin of the superior mesenteric artery just between vertebrae L1 and L2 and posterior to the pancreas.

## Each renal artery enters the kidney via the renal hilum, dividing into segmental branches. These branches undergo further divisions to supply the renal parenchyma.

arteries.

Lymphatic drainage The lymphatic drainage is to the lumbar (para-aortic) lymph nodes located at the origin of the renal

# **Innervation**

The kidneys receive autonomic nerve fibres via the renal plexus which contains parasympathetic fibres from the vagus nerve and sympathetic fibres from the thoracic splanchnic nerves.

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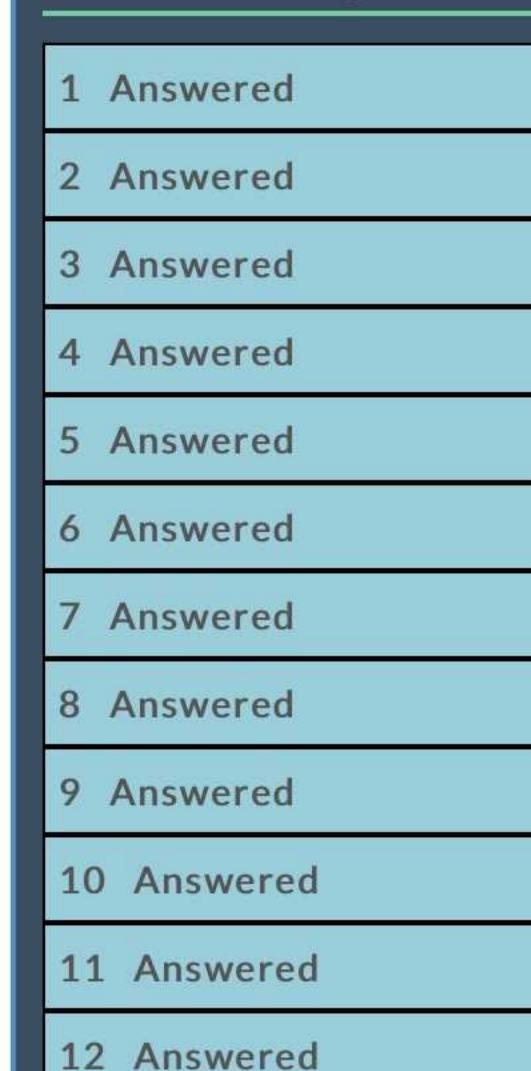
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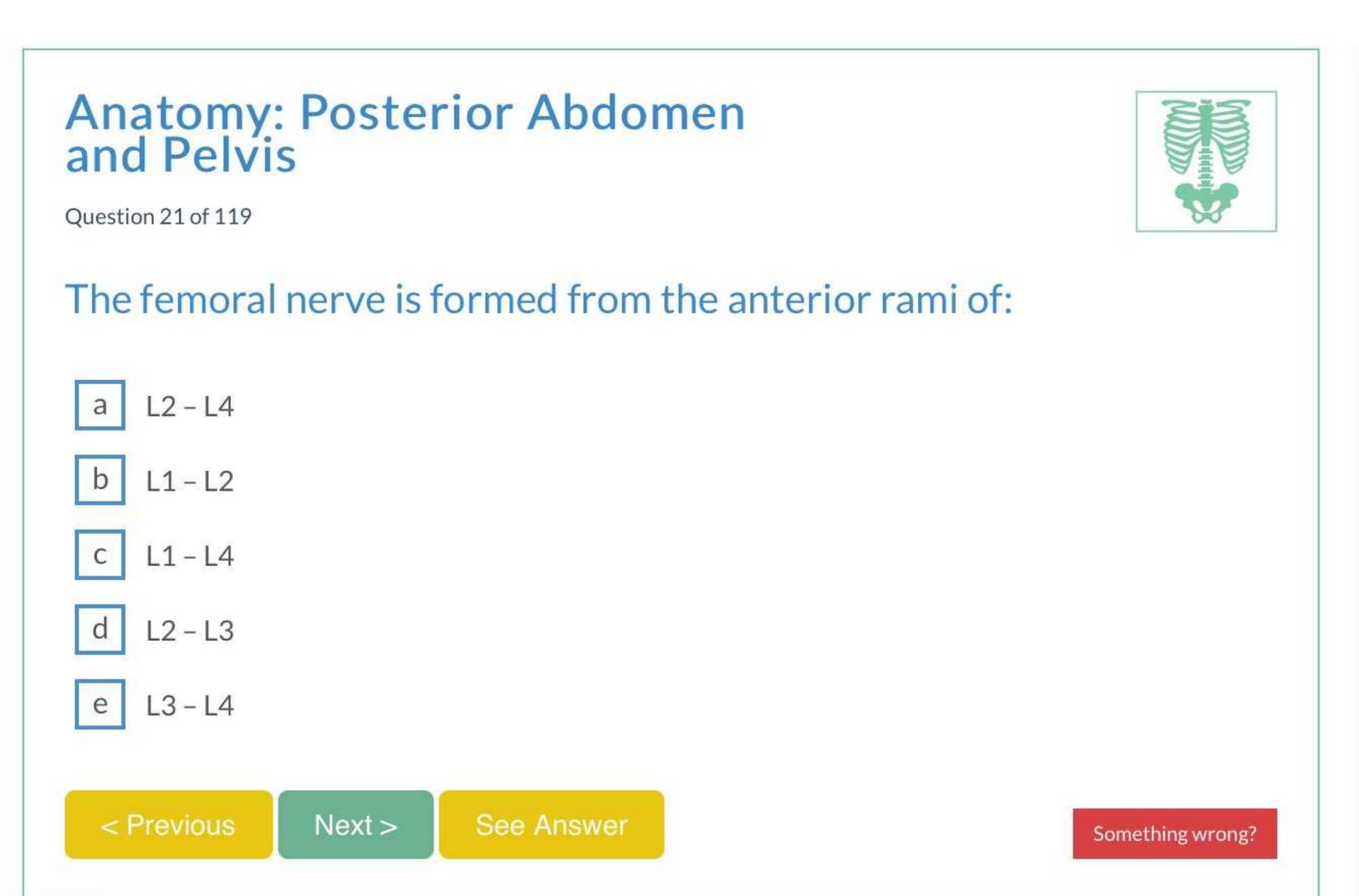
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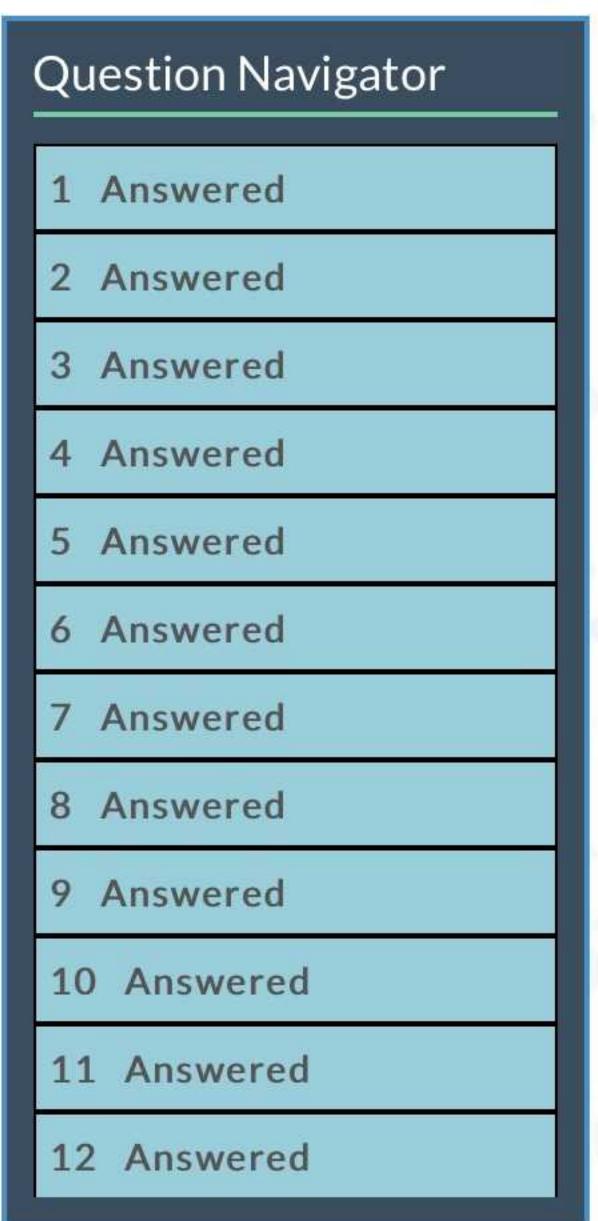
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# Anatomy: Posterior Abdomen and Pelvis

Question 21 of 119



The femoral nerve is formed from the anterior rami of:

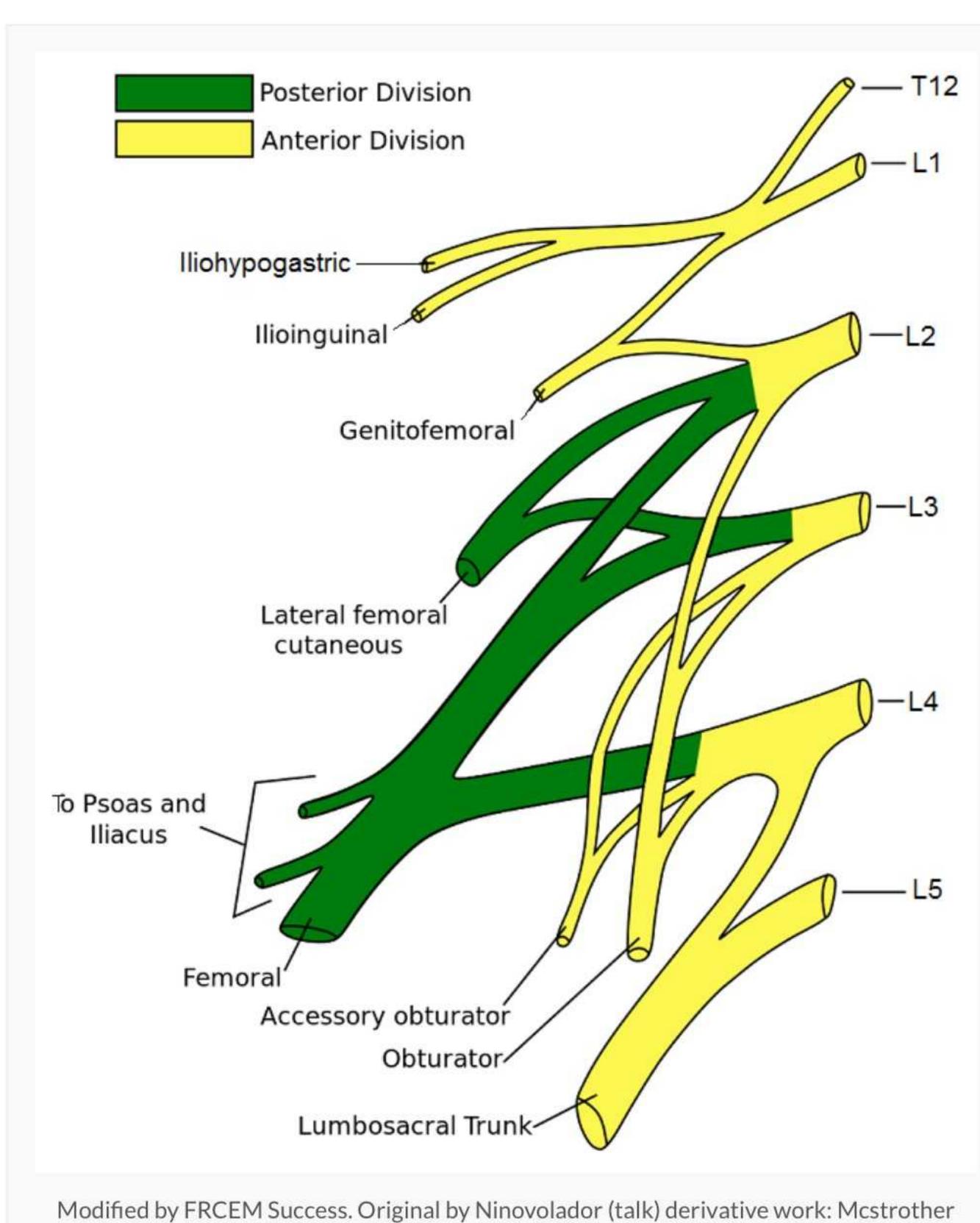
- a) L2 L4 💜
- **b)** L1 L2
- c) L1-L4 d) L2 - L3
- e) L3 L4

## Answer

The femoral nerve is formed from the anterior rami of L2 to L4. It innervates the iliacus, pectineus, sartorius and muscles in the anterior compartment of the thigh and supplies skin on the anterior thigh and medial surface of leg.

## Notes

The lumbar plexus is formed by the anterior rami of nerves L1 – L3 and most of the anterior ramus of L4. It also receives a contribution from the T12 (subcostal) nerve. The lumbar plexus forms within the substance of the psoas major muscle, anterior to its attachment to the transverse processes of the lumbar vertebrae.



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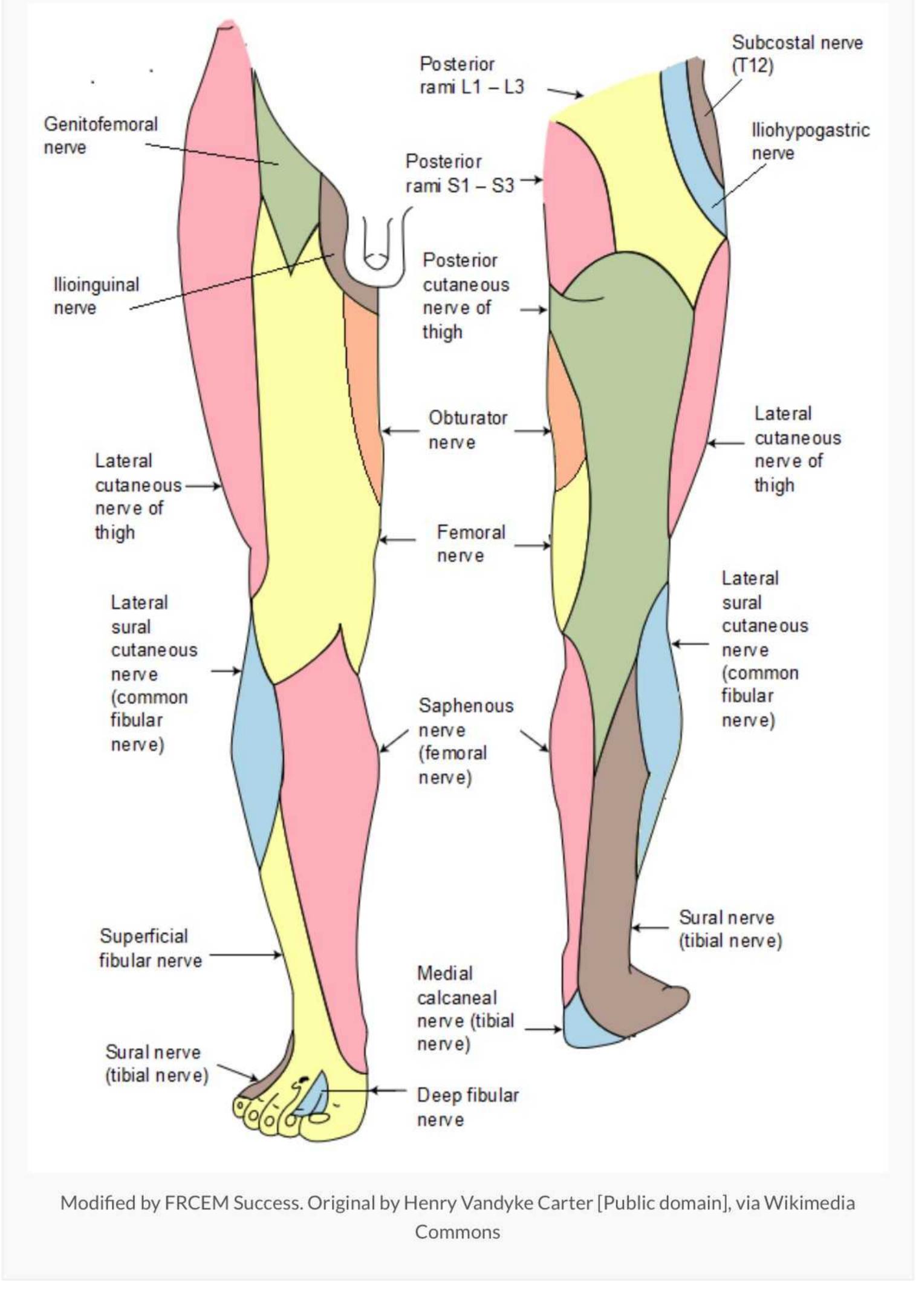
## Lumbar nerves

Nerve	Spinal segment	Motor function	Sensory function
Iliohypogastric nerve	L1	Internal oblique and transversus abdominis	Posterolateral gluteal skin and skin in pubic region
Ilioinguinal nerve	L1	Internal oblique and transversus abdominis	Skin in upper medial thigh, and either skin over root of penis and anterior scrotum or mons pubis and labium majus
Genitofemoral nerve	L1, L2	Male cremasteric muscle	Skin of anterior scrotum or skin of mons pubis and labium majus (genital branch), skin of upper anterior thigh (genitofemoral nerve)
Lateral cutaneous nerve of thigh	L2, L3	N/A	Skin on lateral thigh to knee
Obturator	L2 – L4	Obturator externus, gracilis and adductor muscles	Skin on medial aspect of thigh
Femoral nerve	L2 – L4	Iliacus, pectineus, sartorius and quadriceps femoris	Skin on anterior thigh and medial leg

oblique and the transversus abdominis and supplies posterolateral gluteal skin and skin over the pubic region. • The ilioinguinal nerve is formed from the anterior rami of L1. It innervates the internal oblique

• The iliohypogastric nerve is formed from the anterior rami of L1. It innervates the internal

- and transversus abdominis and supplies skin over the upper medial thigh and the external genitalia. • The genitofemoral nerve is formed from the anterior rami of L1 and L2. Its genital branch
- innervates the male cremaster muscle and supplies skin over the external genitalia and its femoral branch supplies skin of the upper anterior thigh.
- The lateral cutaneous nerve of the thigh (lateral femoral cutaneous nerve) is formed from the anterior rami of L2 and L3. It supplies skin on the anterolateral thigh to the knee. • The obturator nerve is formed from the anterior rami of L2 to L4. It innervates the obturator
- externus and the muscles in the medial compartment of the thigh and supplies skin on the medial aspect of the thigh. • The femoral nerve is formed from the anterior rami of L2 to L4. It innervates the iliacus,
- pectineus, sartorius and muscles in the anterior compartment of the thigh and supplies skin on the anterior thigh and medial surface of leg.



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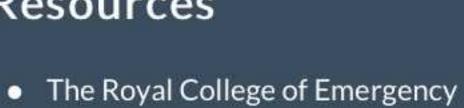
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# Anatomy: Posterior Abdomen and Pelvis

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- Abdominal aorta
- b Internal iliac artery
- External iliac artery
- Coeliac trunk
- Inferior mesenteric artery

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See Answer

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# Anatomy: Posterior Abdomen and Pelvis

Question 22 of 119



The testicular artery is a branch from which of the following blood vessels:

- a) Abdominal aorta
- b) Internal iliac artery
- c) External iliac artery d) Coeliac trunk
- e) Inferior mesenteric artery

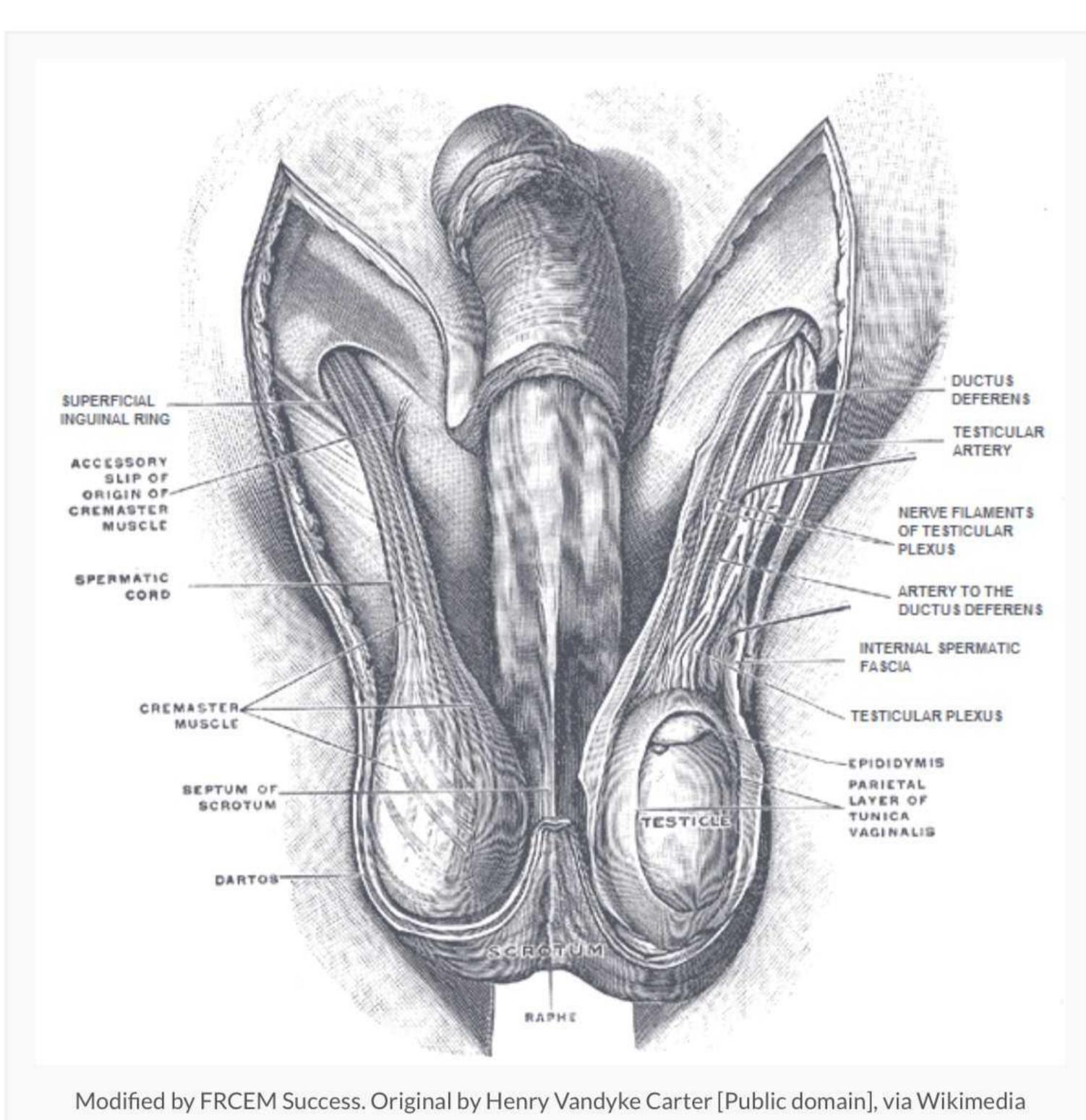
#### Answer

The testes receive their arterial supply from the testicular artery, one of the paired visceral branches of the abdominal aorta, which travels in the spermatic cord.

#### Notes

The testis and epididymis are suspended in the scrotum by the spermatic cord. The inferior pole of the testis is attached to the scrotal wall by the scrotal ligament, which is the remnant of the gubernaculum testis.

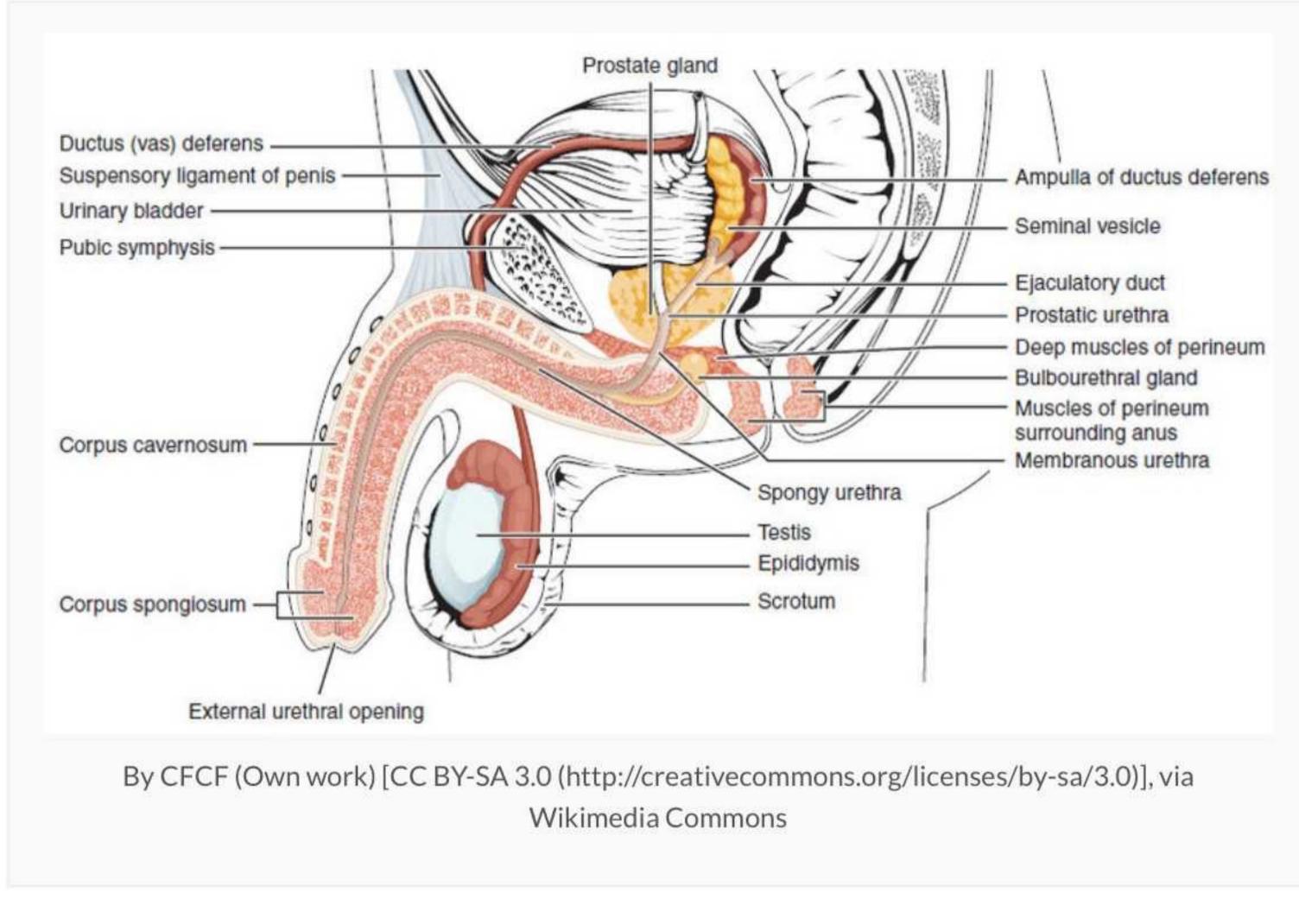
Each testis is composed of seminiferous tubules (which produce spermatozoa) and interstitial tissue (which secretes testosterone) surrounded by a thick connective tissue capsule, the tunica albuginea. The spermatozoa collects in the epididymis, the tail of which is continuous with the ductus deferens, which transports the spermatozoa to the ejaculatory ducts in the pelvic cavity.



## Ductus deferens

The ductus deferens ascends in the scrotum as part of the spermatic cord and passes through the inguinal canal in the anterior abdominal wall. After exiting the inguinal canal through the deep inguinal ring, it enters the pelvic cavity and descends medially on the pelvic wall, deep to the peritoneum, and crosses the ureter posterior to the bladder. It continues inferomedially along the base of the bladder, anterior to the rectum, almost to the midline where it is joined by the duct of the seminal vesicle to form the ejaculatory duct. The ejaculatory duct penetrates through the prostate gland to connect with the prostatic urethra.

Commons



## **Development**

The testes develop high on the posterior abdominal wall and then descend, normally before birth, through the inguinal canal in the anterior abdominal wall and into the scrotum of the perineum. During the descent, the testes carry their vessels, lymphatics, nerves and ductus deferens with them. The spermatic cord is the tube-shaped connection between the pouch in the scrotum and the abdominal wall.

The sides and anterior aspect of the testis are covered by the serous tunica vaginalis, derived from the embryonic processus vaginalis which is originally connected to the abdominal cavity. Normally after testicular descent, the connection closes, leaving a fibrous remnant. Failure of closure can result in the development of an indirect inguinal hernia.

## Blood supply

The testes receive their arterial supply from the testicular artery, direct branch of the abdominal aorta, which travels in the spermatic cord.

## **Lymphatics**

The lymph drainage of the testes is to the lumbar (para-aortic) nodes in the abdomen, in contrast to that of the scrotum which drains to the superficial inguinal nodes.

# Innervation

The testes receive their autonomic nerve supply from the testicular plexus. Visceral afferent fibres usually follow the sympathetic fibres to spinal cord levels T10 - L1; pain is thus referred to the periumbilical region, suprapubic region and groin.

The scrotum is innervated by nerves derived primarily from spinal roots L1 and S2 – S3:

- anterolaterally by the genital branch of the genitofemoral nerve (L1 L2) anteriorly by scrotal branches of the ilioinguinal nerve (L1)
- posteriorly by scrotal branches of the perineal nerve of the pudendal nerve (S3)
- inferiorly by perineal branches of the posterior femoral cutaneous nerve (S2)

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